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# POLLUTION OF THE WATERS OF DADE COUNTY, FLORIDA

Federal Water Quality Administration
Fort Lauderdale, Florida

1970

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United States Department of the Interior
Federal Water Quality Administration
Southeast Water Laboratory
Technical Services Program
Lower Florida Estuary Study
Ft. Lauderdale, Florida

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# DADE COUNTY, FLORIDA

Date = 1970
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something.

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Federal Water Quality Administration
Southeast Water Laboratory
Technical Services Program
Lower Florida Estuary Study
Ft. Lauderdale, Florida

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## INTRODUCTION

In July 1970, the Governor of Florida and the Florida State Air and Water Pollution Control Board requested assistance from the Federal Water Quality Administration in determining the pollution abatement requirements of Dade County.

This report discusses the effects on water quality of the numerous waste sources discharging into the canals, coastal waters and ocean in and adjacent to Dade County. The necessary actions required to alleviate the problem are also discussed. Data for this report were furnished by the Florida State Air and Water Pollution Control Board, and additional data were collected by the Federal Water Quality Administration, Lower Florida Estuary Study.

Cooperation and assistance in the form of data, reports and other information necessary to the preparation of this report have been extended by several agencies and individuals. Their contribution to this effort is gratefully acknowledged.

## SUMMARY

Dade County has experienced sustained population growth for 40 years. The present population of 1.6 million is expected to increase to 2.7 million within 50 years.

About 500,000 to 800,000 people in Dade County are served by individual septic tanks for the disposal of sewage and domestic wastes. There is also a large, but undetermined, number of households which use individual wells for their domestic water supply.

There are 114 separate sewage treatment facilities serving the remaining 1.1 million people.

Approximately 74 of these systems are small package treatment units which serve an estimated half million population.

There are 40 major sewage treatment systems which serve 400,000 people. Thirty of these systems discharge treated effluent into the inland canal system. Four collection systems discharge through three ocean outfalls, and two of these outfall systems have no significant treatment prior to discharge.

At least eight treatment plants are known to be hydraulically overloaded although performance data on all the plants are not available.

The hydrology of Dade County is such that contaminated waters from the inland canal system of the Central and Southern Florida Flood Control District could adversely affect the quality of the ground water which is the source of all municipal water supply in the county.

The ground, surface, estuarine and ocean waters in Dade County are interrelated. The canals recharge ground water and receive water from the ground during dry periods, and they also discharge into Biscayne Bay while water from the Bay is exchanged with ocean water and vice versa.

Inland canal systems in northern Dade County have dissolved oxygen concentrations less than 4.0 mg/l and total coliform bacteria greatly in excess of 1000 MPN/100 ml. Degraded water quality is generally associated with known discharges of municipal wastes. Degradation of water quality increased from 1968 to 1969.

Canal systems in southern Dade County are generally not as severely polluted as those in the north. Two exceptions are Black Creek Canal and Military Canal which discharge severely polluted water into the vicinity of the Biscayne National Monument.

Water quality in the open waters of lower Biscayne Bay is excellent with respect to chemical and bacteriological indicators. Data are insufficient to draw conclusions as to the water quality of upper and central Biscayne Bay.

Coliform bacterial densities near the ocean outfall of the city of Miami Beach are extremely high, ranging from 5,400,000 to 54,000 MPN/100 ml. Coliform densities in the surf along Miami Beach occasionally exceed the criteria of 1000 MPN/100 ml required for recreational waters by the State of Florida.

## CONCLUSIONS

It is concluded that:

1. Septic tanks, widely used in Dade County, are public health hazards and contribute to over-fertilization and algal nuisances in adjacent waterways.

2. The small package treatment units constitute a potentially significant source of organic and bacterial pollution.

3. The present methods for disposal through ocean outfalls without treatment require modification because of public health hazards and the detrimental effects on water quality.

4. The inland waters of northern Dade County are grossly polluted and are in violation of the Dade County and the federally adopted State of Florida Water Quality Standards.

5. The inland waters of southern Dade County are showing signs of severe water pollution as evidenced by fish kills in the area.

6. The major cause of poor water quality in Dade County is inadequately treated municipal sewage effluent.

7. Further study is needed to determine:

   A. Water quality of central and upper Biscayne Bay.

   B. The interrelationship between the canal system and the ground water and between the canal system and the estuarine and coastal waters.

## RECOMMENDATIONS

To abate the existing gross pollution of the inland waters of Dade County and to provide a basis for the enhancement and management of future water quality of all the waters in the area, the following actions are recommended:

1. Completion of an up-to-date inventory of waste sources in Dade County with an evaluation of the performance of each of the 40 major treatment plants by April 1, 1971.

2. Immediate upgrading of existing treatment plant performance through improved operations.

3. Abatement of all wastes being discharged to the inland canal system of Dade County by January 1, 1973 -- the target date set by the Florida Air and Water Pollution Control Board and adopted by The Secretary of the Interior for compliance with approved water quality standards. All existing sewage systems should be regionalized into a county-wide system of central collection and treatment facilities with disposal of treated effluents to the ocean. Secondary treatment be provided for municipal wastes as required by the State of Florida before discharge to the ocean.

4. Inclusion in a county-wide sewage collection and treatment system of all areas presently served by individual septic tanks. Approved plans for sewage collection systems for these areas should be prepared by August 1, 1971 and coordinated with design and construction of adequate sewage treatment facilities. No permits should be granted for future construction of septic tank systems.

5. No future additional waste discharges to Lower Biscayne Bay and its tributaries including the Biscayne National Monument. Removal of existing municipal and industrial waste discharges should be considered for protection of the present high quality of these waters.

6. Review of the operations of the Central and Southern Florida Flood Control District to determine its effect upon the water quality of the inland canal system and the receiving estuarine waters.

7. Development of a regional water management plan, including quality and quantity, for the entire southeast Florida population corridor. Such a plan must be developed jointly by all local, State and Federal interests and should include considerations of advanced

waste treatment, groundwater recharge, waste water reclamation, control of freshwater discharge to the estuarine and ocean waters and the effects of future developments on the water quality and supply of southeast Florida.

## AREA

Dade County is the largest county in Florida with an area of 2052 square miles, of which less than 200 is presently under development.(1) An additional 650 square miles of land in the county is readily developable. The land presently under development is on the Atlantic Coast Ridge, which extends down the east coast from the northern county line to Homestead. The remainder of the county, south and west of the Atlantic Coastal Ridge, consists of the Everglades. Most of the Everglades National Park is located in Dade County.(Figure 1)

The City of Miami is a light manufacturing center, in which the major types of production are: food products, fabric products, furniture and fixtures, printing and publishing, and fabricated metal products.(1) Industries producing these items account for 33.2 per cent of the total manufacturing firms in the Metropolitan Miami area.

The largest employers in the county are service organizations, including hotels and restaurants. Dade County is a major vacation resort, and in 1969 almost 200,000 overnight facilities were available.(1) Restaurants in the county had a seating capacity for over 200,000 customers. The center of the resort area is Miami Beach, which is located on the barrier islands that separate the eastern coast from the Atlantic Ocean.

The highly productive agricultural area south of Miami produces tomatoes, potatoes, limes, avocados, mangos and many other crops during the entire year. Biscayne Bay, another economic asset, is an important

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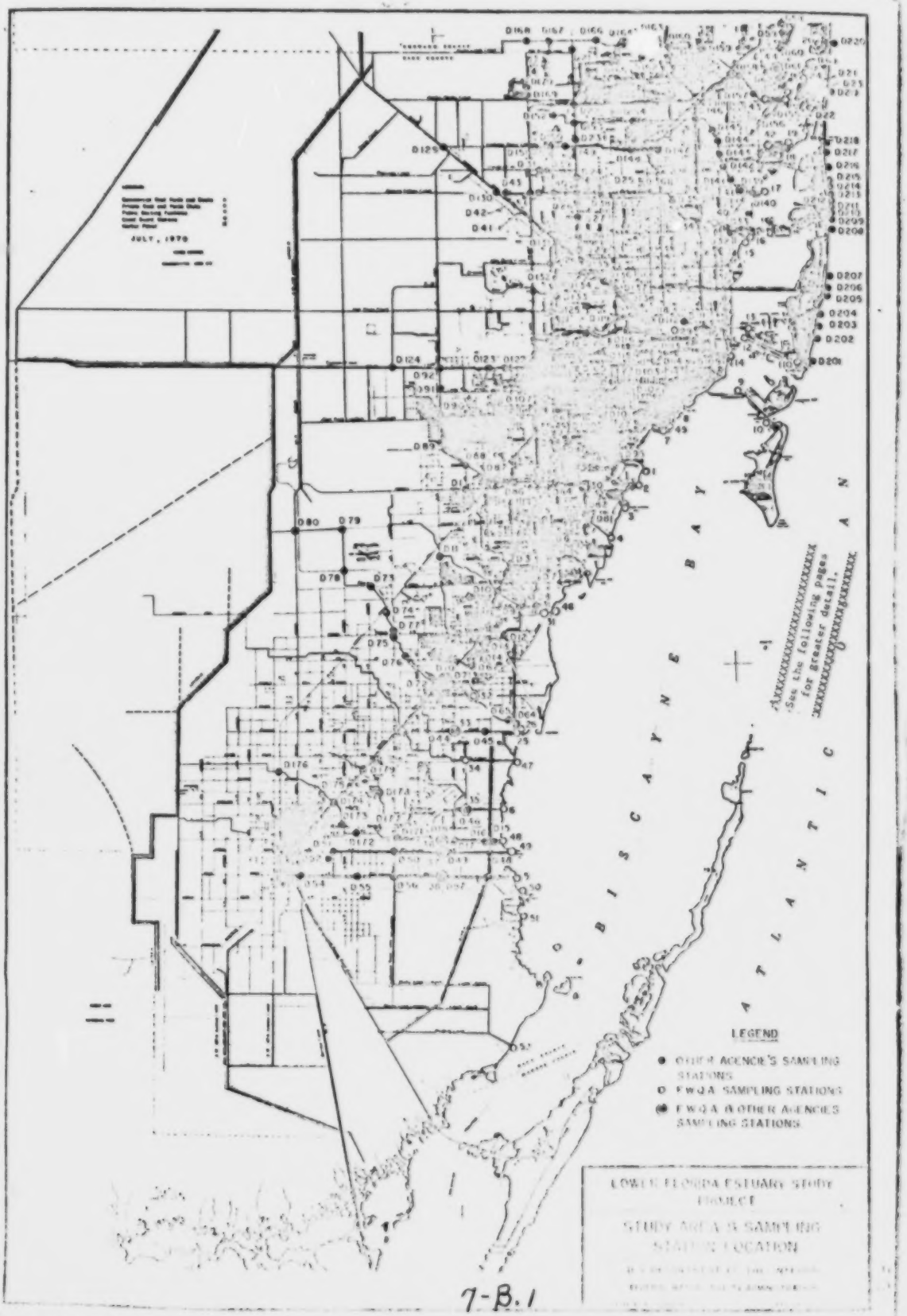
(1) Metropolitan Miami Manufacturers Guide, 1970.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BISCAYNE BAY
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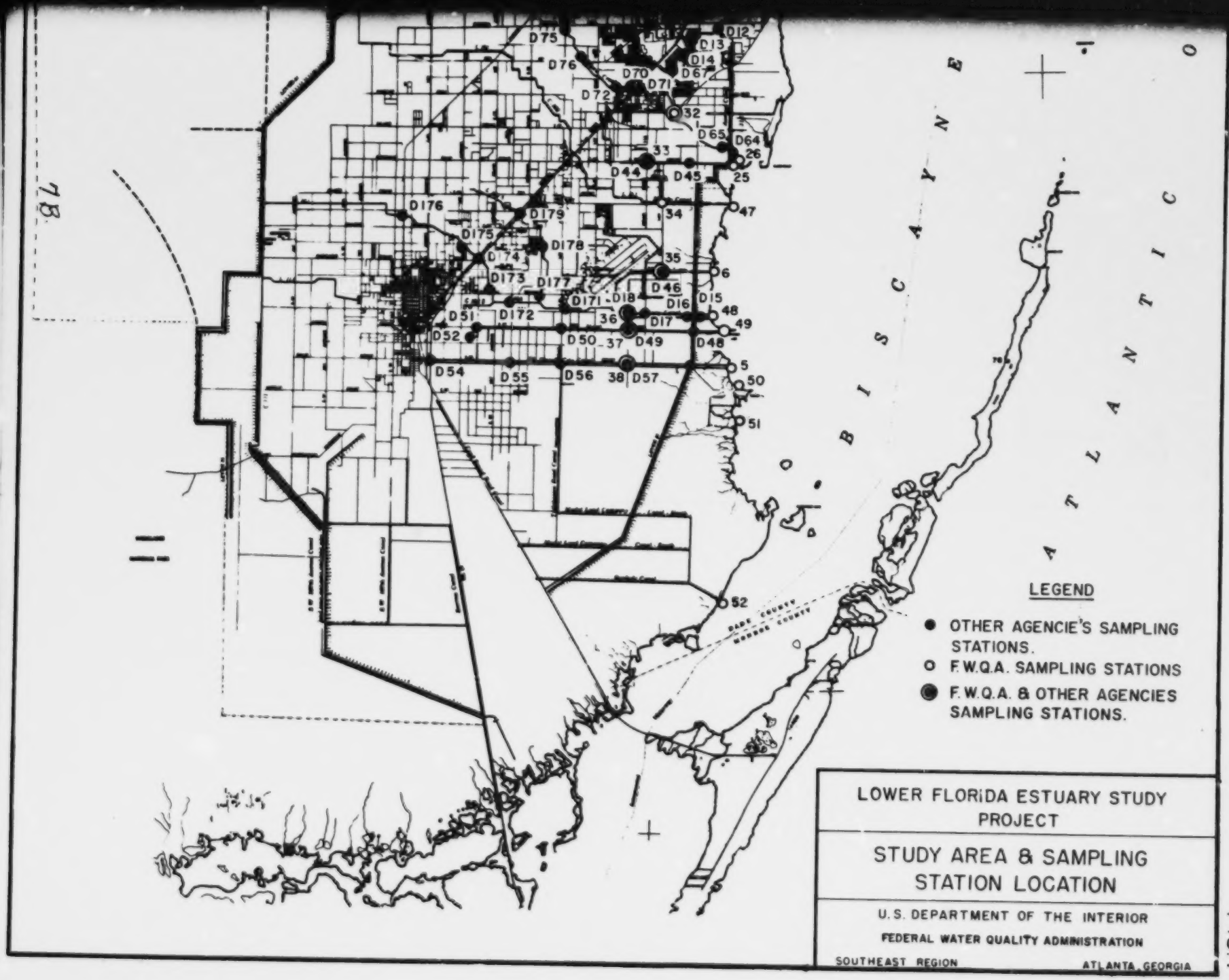
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LEGEND
OTHER AGENCIE'S SAMPLING STATIONS.
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F.W.Q.A. & OTHER AGENCIES SAMPLING STATIONS.
LOWER FLORIDA ESTUARY STUDY PROJECT
STUDY AREA & SAMPLING STATION LOCATION
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER QUALITY ADMINISTRATION
SOUTHEAST REGION
ATLANTA, GEORGIA

FIG. 1

commercial fishery. In 1965, bait shrimp valued at $393,600, stone crabs valued at $145,828, and spring lobsters valued at $81,000 were landed in the bay.(2) The bay is also an extremely important recreation area, which is used for sports fishing, boating, water skiing, swimming and diving, among other uses.

CLIMATE

The climate of Dade County and all of southeast Florida is characterized by warm weather, usually ample rainfall and light but persistent winds. Mean annual temperature is around 75°F with summer highs about 82°F and winter lows about 67°F as a daily average. Record low temperatures of 26-28°F have been recorded in southern Dade County.

Average annual precipitation is about 60 inches/year. However, during hurricanes rainfall rates may be as high as 10 inches or more in 24 hours resulting in above average yearly rainfall and short term severe flooding. Rainfall deficiencies of up to 30.6 inches/year below average have also been recorded.

Wind speed averages about 9.3 miles per hour on a yearly basis. Here again, hurricanes offer an extreme condition with winds occasionally gusting over 100 mph. Calms (< 3 mph) occur frequently but are usually of short duration.

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(2) Idyll, C. P., "Economically Important Marine Organisms in Biscayne Bay", Division of Fisheries Science, Institute of Marine Science, University of Miami.

"Climate" Reference: Water Resources of Southeastern Florida, USGS Water Supply Paper No. 1255, dated 1955.

Evaporation tests conducted around Belle Glade in Palm Beach County, resulted in an annual estimated evaporation rate of 64.33 inches/year. Special studies in the Miami area show the evapotranspiration rate to be about 35 inches/year. Thus up to 2/3 of the total precipitation may be lost, leaving a usable surface water supply of slightly over 20 inches/year.

## HYDROLOGY

The major inland waterways in Dade County are canals which connect the Everglades and Conservation Areas 3A and 3B in the western part of the county with the urban and agricultural areas located on the coastal highlands adjacent to Biscayne Bay. Flow in these canals is controlled by structures operated by the Central and Southern Florida Flood Control District. The canals are operated to prevent floods, recharge the groundwater, and to prevent salt water intrusion.

During periods of heavy rainfall, the canals carry excess runoff to Biscayne Bay and reduce flooding of the low lands in Dade County. When rainfall is light the canals will be used to collect runoff from the urban areas for backpumping to the Water Conservation Areas, where groundwater recharge occurs.

All the canals discharging to Biscayne Bay are equipped with salinity dams which allow freshwater to flow into Biscayne Bay but prevent salt water from entering the canals.

### Surface Water

The most significant waterways in Dade County with respect to hydrology are Snake Creek, Miami, Snapper Creek, Little River, Tamiami,

and Biscayne Canals and Taylor Slough. The combined flow from the canals during the period 1960 to 1968 averaged 1460 cfs, which was 75 percent of the total eastward runoff from all Dade County Canals.(3)

Snake Creek Canal has the greatest discharge of any Dade County coastal canal. It is 21.5 miles long and has a drainage basin of 84 square miles.(4) Flow is regulated by two gated control structures, one at the eastern edge of Conservation Area 3B and the other near the mouth. During the 1960-to-1968 period, the average discharge at the salinity dam was 403 cfs, the highest flows occurred during September and October, and the lowest discharges were measured during March and April.

Miami Canal is Dade County's second largest coastal canal with a length of 20.0 miles and a drainage area of 111 square miles. The salinity control structure on this waterway is located 5.7 miles upstream of the mouth. The discharge just upstream of the salinity dam averaged 347 cfs during the 1960-to-1968 period. During this period, the highest discharges at this location occurred during September, October, and November, and the lowest occurred during April and May.

Flow and physical data for the remainder of the canals are presented in Table 1.

---

(3) Hull, J. E. and Galliher, C. F., "Hydrologic Conditions During 1968 in Dade County Florida", USDI, Geological Survey, Water Resources Division, Tallahassee, Florida, March 1970.

(4) Gazetteer of Florida Streams, Division of Water Resources and Conservation, Florida Board of Conservation, Tallahassee, Florida, 1966.

TABLE 1

SUMMARY OF HYDROLOGIC AND PHYSICAL DATA

FOR

MAJOR DADE COUNTY CANALS

| WATERWAY | LENGTH (2) MILES | DRAINAGE AREA (2) SQUARE MILES | AVERAGE DISCHARGE 1960 to 1968 cfs |
|---|---|---|---|
| Snake Creek Canal | 21.5 | 84.0 | 403 |
| Miami Canal | 20.0 | 111.0 | 347 |
| Snapper Creek Canal | 12.0 | 42.6 | 263 |
| Little River Canal | 10.6 | 28.0 | 157 |
| Tamiami Canal | 17.0 | 55.0 | 144 |
| Biscayne Canal | 11.0 | 27.2 | 149 |
| Taylor Slough (North of State Highway 27) | 10.0 | 40.0 | 47.4 |

Taylor Slough is a natural drainage basin located in the eastern part of the Everglades National Park. Its headwaters are about ten miles north and west of State Highway 27, and it flows southward to Florida Bay. Its drainage basin north of State Highway 27 is approximately 40 square miles. The average discharge at Highway 27 was 47.4 cfs; however, there is no discharge at this location for long periods each year.

Ground Water

The principal source of potable, industrial and agricultural water supply in Dade County is the Biscayne aquifer. This is a highly permeable limestone and sandstone formation which is 80 to 150 feet thick on the east coast and diminishes to about ten feet thich on the western side of the county. Ground and surface water levels in Dade County are interconnected since the Biscayne aquifer extends to just below ground surface. The water table rises with local rainfall, surface water inflow and seepage from the conservation areas. On the other hand, it drops in response to losses by evapotranspiration, and surface water outflow.

The water table in northeastern Dade County has been relatively stable since the completion of the canal system in that area during 1955. The canal system in southeast Dade County was not complete as of 1968 and much greater fluctuation of the water table was observed in this area.(3)

There are two major municipal water supply well fields in the metropolitan Miami area. The Hialeah-Miami Springs well field is located in the vicinity of the Miami Canal and produced an average of 80 million

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(3) Hull, J. E. and Galliher, C. F., "Hydrologic Conditions During 1968 in Dade County Florida", USDI, Geological Survey, Water Resources Division, Tallahassee, Florida, March 1970.

gallons per day (mgd) in 1968.[3] The southwest Dade well field is located near the Snapper Creek Canal and its average pumpage was 60 mgd for 1968.[3] Figure 2 illustrates the annual average pumpage for the City of Miami well field from 1931 to 1968. The average pumpage has increased logarithmically from 11 mgd in 1931 to 140 mgd in 1968.

Tidal Waters

Tidal waters of eastern Dade County consists of Dumfoundling Bay, Biscayne Bay and Card Sound, which are semi-enclosed tropical lagoons separated from the Atlantic Ocean by a narrow chain of barrier islands. The mean tidal range of the Atlantic Ocean near Miami Harber entrance is 2.5 feet. Biscayne Bay is connected to the ocean by broad shoals and deep narrow tidal surge channels. Tidal exchange of water between the ocean and Biscayne Bay and between Biscayne Bay and Card Sound is progressively retarded by shoals and keys. Reduced mean tidal ranges in Biscayne Bay and Card Sound graphically depict this flow retardation. The mean tidal range in upper Biscayne Bay is 1.9 feet and that in the lower bay was 1.4 feet. The mean tidal range in Card Sound is 0.8 feet.

POPULATION

Dade County has experienced a sustained population growth for about 40 years. This growth is expected to continue for the next 50 years. Table 2 shows the historical and projected population of the county from 1930 through 2020.

---

(3) Hull, J. E. and Galliher, C. F., "Hydrologic Conditions During 1968 in Dade County Florida", USDI, Geological Survey, Water Resources Division, Tallahassee, Florida, March 1970.

FIGURE 2

2 AVERAGE DAILY PUMPAGE
CITY OF MAIMI WELL FIELDS
1930-1968
(FROM REFERENCE 3)

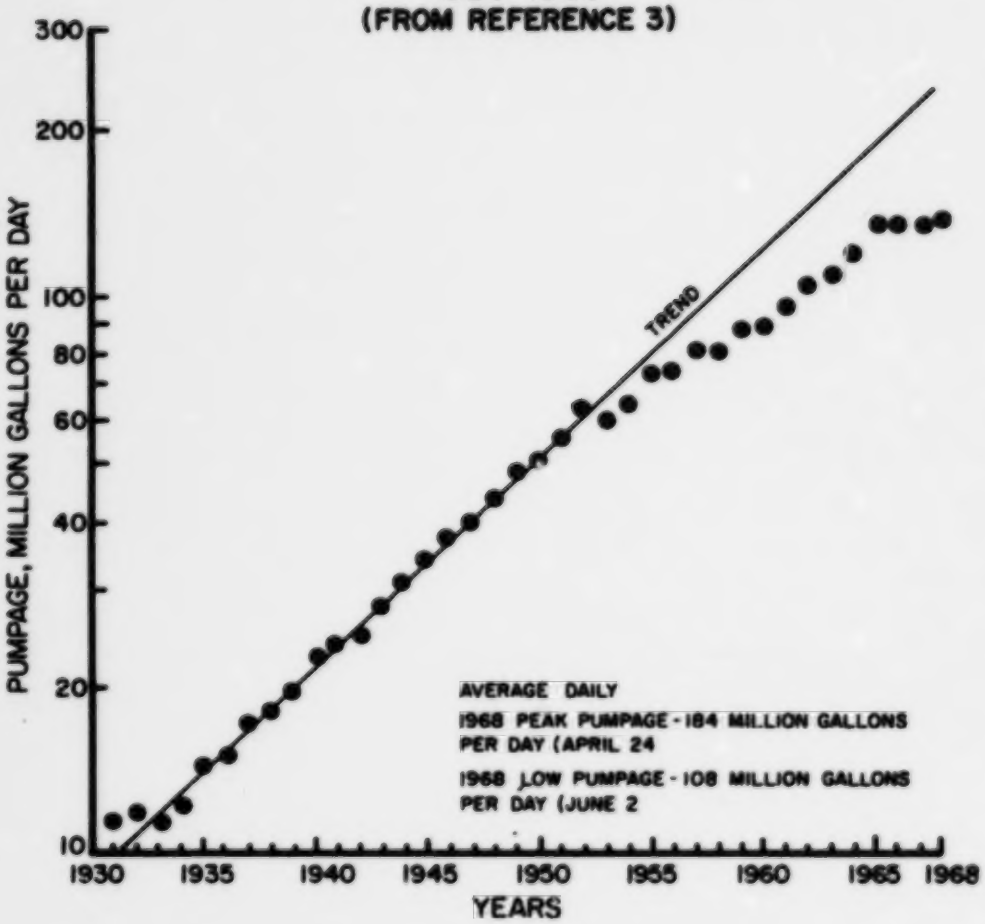


TABLE 7

POPULATION

DADE COUNTY, FLORIDA

| Year | Urban Population | Rural Population 1/ | Total Residential Population | Occasional Residents and Tourists | Total Peak Seasonal Population |
|---|---|---|---|---|---|
| 1930 | | | 142,995 | | |
| 1940 | 215,590 | 52,149 | 267,739 | | |
| 1950 | 466,079 | 29,005 | 495,084 | | |
| 1960 | 894,342 | 40,705 | 935,100 | | |
| 1970 | 2/ | 2/ | 1,259,184 | | |
| 1980 3/ | 1,398,300 | 1,700 | 1,400,000 | 370,400 | 1,770,400 |
| 2000 3/ | 1,798,800 | 1,200 | 1,800,000 | 456,000 | 2,256,000 |
| 2020 3/ | 2,099,600 | 400 | 2,100,000 | 582,000 | 2,682,000 |

1/ Pre 1970 figures reflect population in rural areas, post 1970 figures reflect rural-farm population only.

2/ 1970 total population figures are preliminary only.

3/ Projections by Florida Social Sciences Advisory Committee, August 1969.

Preliminary 1970 census figures indicate 1,259,184 residents in Dade County. It is estimated that at the peak of the tourist season, there were about 320,000 tourists and occasional residents. Thus the total population for which municipal services should have been provided in 1970 was near 1,580,000.

Fifty year projections indicate a continued growth in both urban residential and tourist and occasional residents, with a severe loss in the rural-farm population.(5) Within the next decade, municipal utility services must be prepared to serve almost 1.8 million people and by 2020 these services must be available to almost 2.7 million people.

While Dade County has a total area of 2,052 square miles, much of the area is devoted to conservation areas and the Everglades National Park. It is estimated that the remaining area suitable for habitation development is only about 650 square miles.

A 1964 traffic study reports population densities as high as 377.6 persons per acre in a small section of downtown Miami and densities of over 100 persons per acre in 14 study areas covering 5,200 acres.

## SOURCES OF DATA

Information on municipal waste sources was obtained from three inventories: FWQA STORET listings, State Department of Health and Rehabilitative Services inventory and State Department of Air and Water Pollution Control inventory.

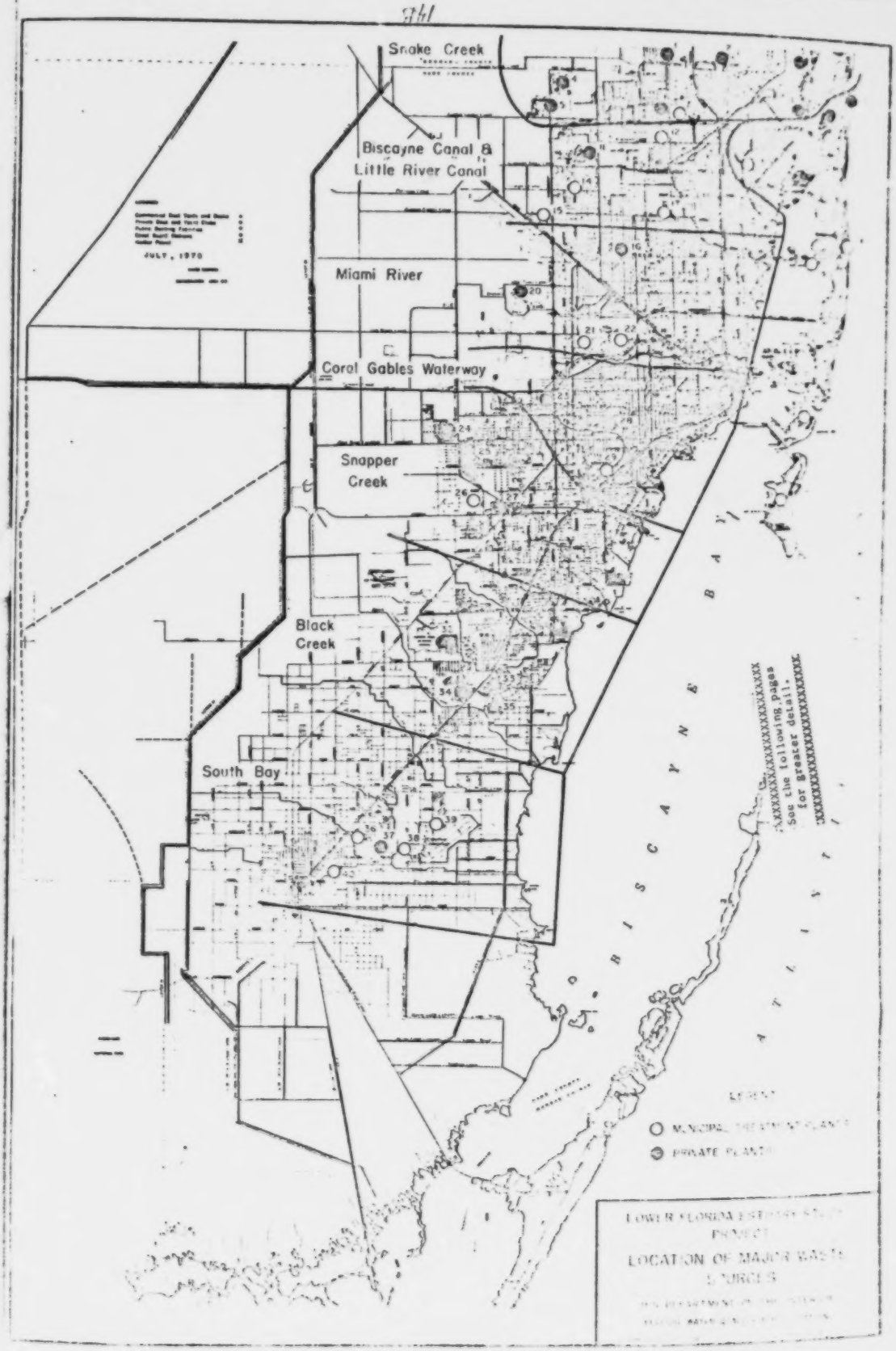
---

(5) Florida County Population Projections developed by the Florida Social Science Advisory Committee. August 1969.

Water quality data for the fresh water portions of the canal system originated with the Dade County Pollution Control Department and was obtained through the Florida Department of Air and Water Pollution Control. Water quality data for the estuarine portions of the canals and near shore areas of Biscayne Bay were collected by FWQA, Lower Florida Estuary Study.

Finally, coliform bacteria data from the bathing beach areas of the Atlantic Ocean were obtained from the Dade County Health Department and coliform bacteria data around the ocean outfalls came from Dade County Pollution Control Department.

After careful review, it was determined that inventory information is incomplete and out-of-date and that specific conclusions and recommendations regarding individual waste sources could not be made on the basis of that information. However, the water quality data are believed to be generally sound and reliable although several irregularities were noted in tabulated water quality data.


Snake Creek
Biscayne Canal &
Little River Canal
JULY, 1970
Miami River
Coral Gables Waterway
Snapper
Creek
Black
Creek
South Bay
BISCAYNE BAY
ATLANTIC
xxxxxxxxxxxxxxxxxxxxxxxx
See the following pages
for greater detail.
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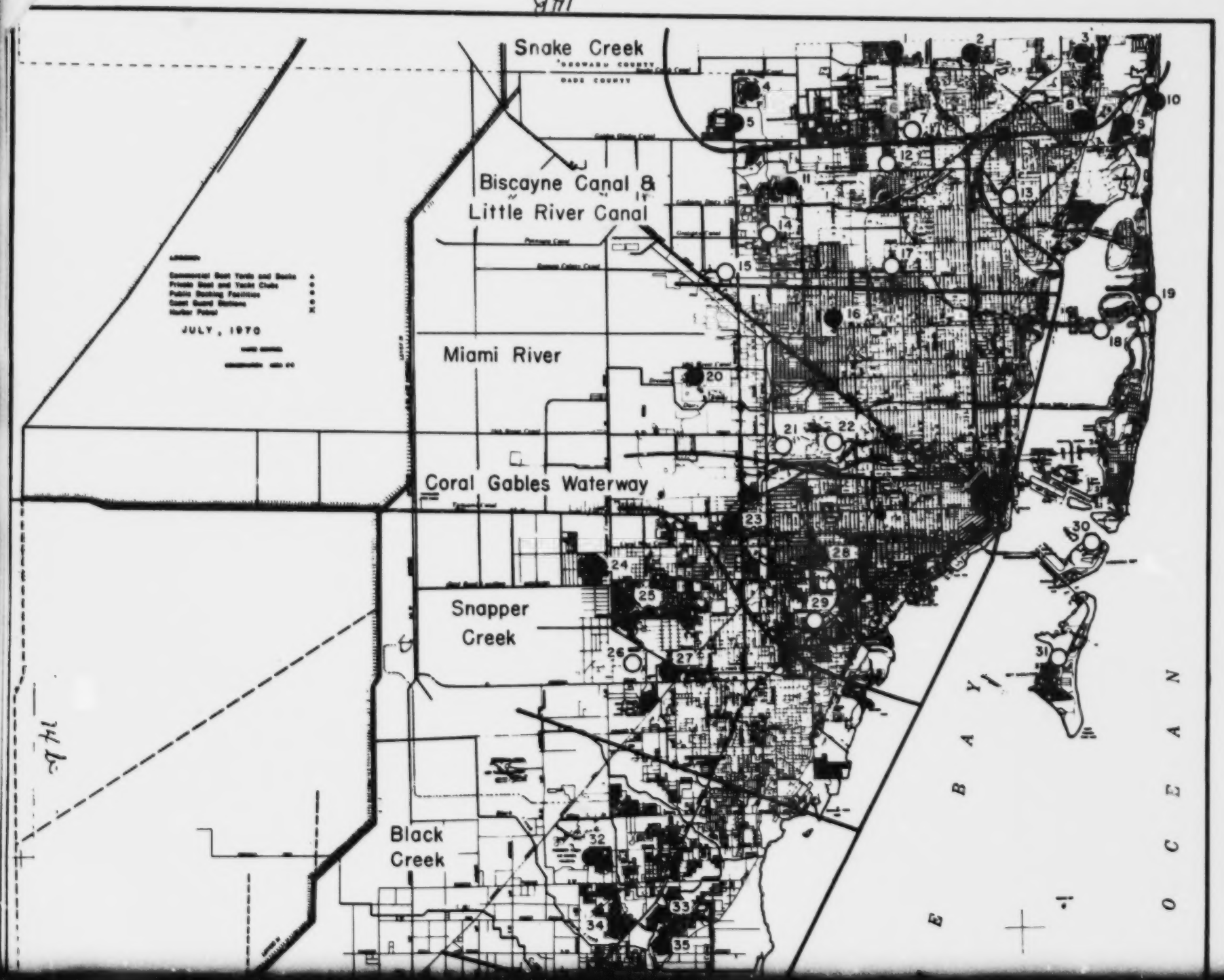
LEGEND
MUNICIPAL TREATMENT PLANTS
PRIVATE PLANTS
LOWER FLORIDA KEYS WATER QUALITY
PROJECT
LOCATION OF MAJOR WASTE
SOURCES


Snake Creek
BROWARD COUNTY
DADE COUNTY
Biscayne Canal &
Little River Canal
Miami River
Coral Gables Waterway
Snapper
Creek
Black
Creek
JULY, 1970
BAY
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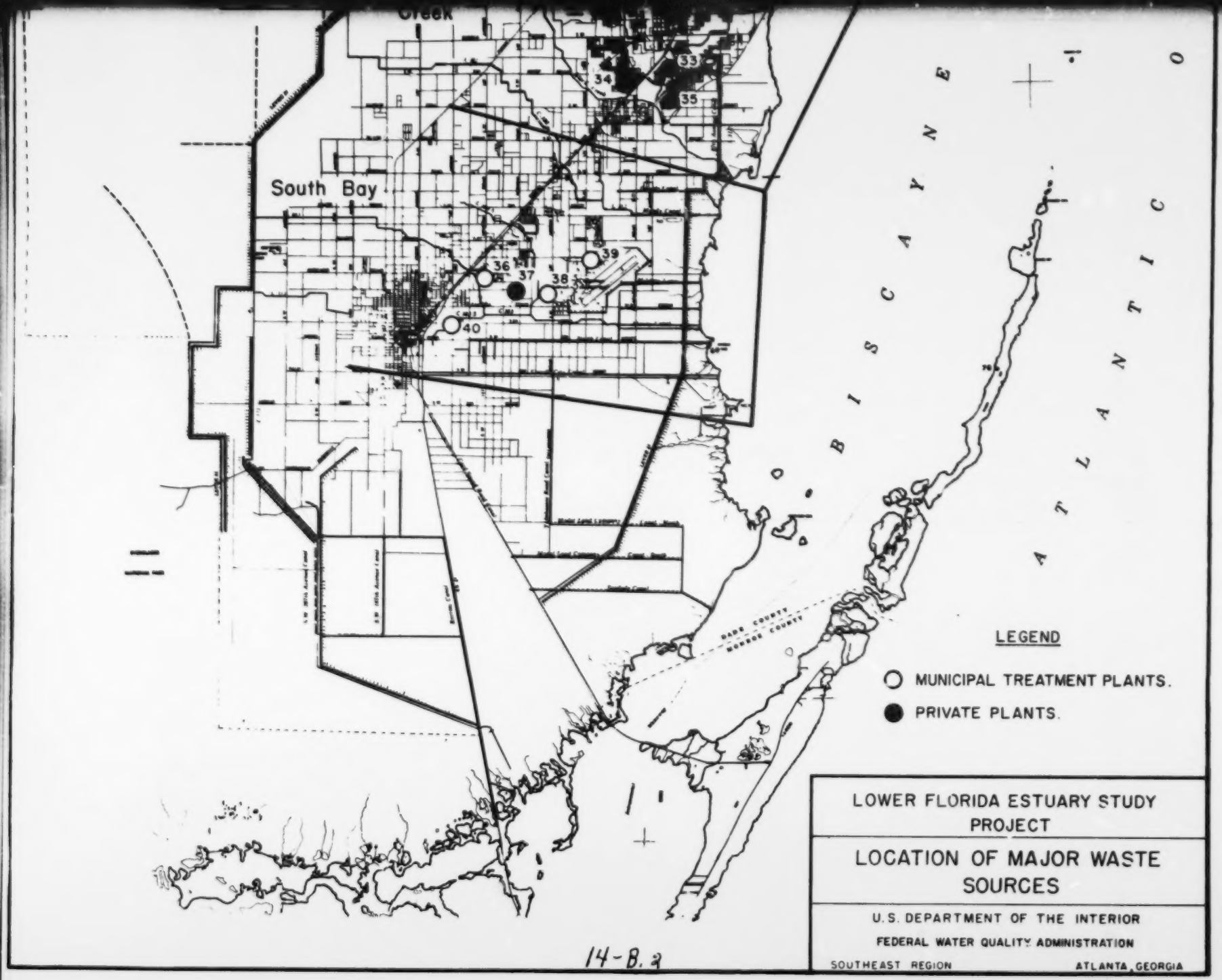
Creek
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MUNICIPAL TREATMENT PLANTS.
PRIVATE PLANTS.
LOWER FLORIDA ESTUARY STUDY PROJECT
LOCATION OF MAJOR WASTE SOURCES
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FEDERAL WATER QUALITY ADMINISTRATION
SOUTHEAST REGION
ATLANTA, GEORGIA

14-B.2

FIG. 3

## WASTE SOURCES

### MUNICIPAL WASTES

There are 114 separate sewage treatment installations in Dade County (Table 3). Of these 114, forty are considered major systems serving an estimated 421,700 persons. This represents only 27% of the total population served by sewage collection systems and major treatment plants (Figure 3).

Twenty-one of the 40 major treatment facilities are privately owned; the remaining 19 being owned by city, county or Federal governmental units.

County-wide treatment facilities have an installed capacity of over 181 million gallons per day (mgd) and an estimated actual flow of 100.1 mgd; however, almost all of the excess capacity is in two systems using ocean outfalls without treatment, namely North Miami and Miami. Design and flow data are not available for all the treatment facilities. Of 27 systems for which such data are available, eight are hydraulically overloaded. Those eight plants have an installed capacity of 5.6 mgd and an estimated flow of 7.9 mgd. They are: Riverdale Estates, Andover, Miami Lakes, Westwood Lakes, Snapper Creek Park, Bel-Aire (Perrine), South Miami Heights, and South Dade Labor Camp which is federally owned.

Thirty systems having a combined flow of 24.8 mgd discharge treated effluent into the inland canal system. These canals are operated for flood control and may have prolonged periods of minimal flow. In these

TABLE 3
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY*

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| Andover S/D (2) | 0.350 | 0.673 | 3500 | 1915 | | | Tr. Filt. | Snake Crk. Canal |
| Atomic Sewerage Plant | 0.030 | | | | | | Extended Aeration | FEC Canal |
| Barry College | 0.030 | | | | | | Rated Aeration | Subsurface |
| Beaux Arts Apartments | 0.022 | | | | | | Septic Tank & Sand Filter | Biscayne Bay |
| Beefster Restaurant | 0.014 | | | | | | Extended Aeration | Subsurface |
| Bel-Aire S/D (33) | 0.210 | 0.289 | 2100 | 2000 | | | Trickling Filter | Ground |
| Biscayne Osteopathic Hospital | 0.02 | | | | | | Extended Aeration | Snake Crk. Canal |
| Blue Lake Development Corporation | | | | | | | Extended Aeration | Subsurface |
| Camp Matecumbe | 0.035 | | | | | | | |

* From listings furnished by The Florida Air & Water Pollution Control Board.

NOTE: Number in parenthesis indicates location of waste source on Figure 3.

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| Carol City S/D (6) | 3.5 | 2.2 | 35000 | 4620 | | | Activated Sludge | Snake Crk. Canal |
| Carriage House Motel | 0.018 | | | | | | Rapid Bloc | Subsurface |
| Casa Granada | | | | | | | | |
| Chatlos Motel & Apartments | 0.103 | | | | | | Trickling Filter | Dumfounding Bay |
| Coastal Towers Apartments | 0.100 | | | | | | Septic Tank | Intracoastal Waterway |
| Cocoanut Grove Apt. Building | 0.008 | | | | | | Extended Aeration | Biscayne Bay |
| City of Coral Gables (29) | 2.5 | 2.36 | 10000 | 9650 | | | Activated Sludge | Snapper Creek |
| Coral Reef Nursing Home | 0.03 | | | | | | Extended Aeration | |
| Country Club Estates (4) | 0.2 | 0.096 | 2000 | 1000 | | | Contact Stabilization | Snake Crk. Canal |
| Dade County Home and Hospital (26) | 0.135 | | | | | | Trickling Filter | Snapper Creek Canal |

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| Dade County Junior College (17) | 0.216 | | 2160 | | | | Trickling Filter | Little River |
| Dade County Port Authority (Opa (12) Locka) | 1.0 | | 10000 | | | | Trickling Filter | Biscayne Canal |
| Doral Country Club (20) | 0.216 | | 2160 | | | | Contact Stabilization | Tamiami Canal |
| Dunes Shopping Center | 0.012 | | | | | | Trickling Filter | Dumfounding Bay |
| Eagle Apartments House | 0.011 | | | | | | Extended Aeration | Subsurface |
| Eastern Shores S/D (9) | 0.300 | 0.166 | 3000 | 1000 | | | Contact Stabilization | Intracoastal Waterway |
| Edelphi Building | 0.013 | | | | | | Extended Aeration | Subsurface |
| FAA Air Route Control Center | 0.009 | | | | | | Rated Aeration | 58th St. Canal |
| Food Fair Store | 0.015 | | | | | | Extended Aeration | Subsurface |
| Gelvan, Inc. | | | | | | | | |
| Golden Isles S/D (3) | 0.5 | 0.485 | 5000 | 3000 | | | Contact Stabilization | Oleta River |

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TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| Grove Bay Village Apartments | 0.0175 | | | | | | | |
| Helman Apartments | 0.0063 | | | | | | Extended Aeration | Biscayne Bay |
| City of Hialeah (Delray Gardens) | (15)0.04 | | 400 | 400 | | | Extended Aeration | Subsurface |
| City of Hialeah (Lake Cecile Estates) | (14) 0.210 | 0.205 | 2100 | 2000 | | | Contact Stabilization | Canal C-7 |
| Hialeah City Hall Complex | 0.040 | | | | | | Contact Stabilization | Gratigney Rd. Canal |
| Hialeah Jr. High School | 0.030 | | | | | | | Subsurface |
| Hialeah Homes, Inc. | 0.040 | | | | | | Extended Aeration | Subsurface |
| Hialeah Race Course | (16) 0.120 | | 1200 | 10000 | | | | Canal C-7 |
| Hilton Inn Motor Hotel | 0.070 | | | | | | Primary | Subsurface |
| Holiday Inn | 0.0325 | | | | | | Extended Aeration | Miami River |
| Homestead Air Force Base | (39) 2.3 | | 23000 | | | | Extended Aeration | Miami River |
| | | | | | | | Trickling Filter | Military Canal |

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| City of Homestead (40) | 1.2 | 0.99 | 12000 | 10000 | | | Contact Stabilization | North Canal |
| Hot Shoppes Commissary | 0.2 | | | | | | | |
| Howard Johnson's Motor Lodge | 0.025 | | | | | | Mechanical Aeration | Tamiami Canal |
| International House of Pancakes | 0.0075 | | | | | | Contact Stabilization | Tamiami Canal |
| Kendal Lakes S/D | | | | | | | Contact Stabilization | Bella Vista Waterway |
| Key Biscayne Water Co. (31) | 0.262 | 0.250 | 2620 | 1365 | | | Trickling Filter | Atlantic Ocean via Virginia Key |
| Kelbba Apartments | 0.038 | | | | | | | |
| Lakeshore S/D | | | | | | | Contact Stabilization | Snapper Crk. Canal |
| Lasalle Immaculeta | 0.021 | | | | | | | |
| Leisure City (37) | 0.262 | 0.220 | 2620 | 3100 | | | Extended Aeration | Biscayne Bay |
| Man-Vil Co-Op Apartments | 0.015 | | | | | | Sand Filter | Subsurface |
| Maule Lake S/D (8) | 0.040 | | 400 | | | | Extended Aeration | Snake Crk. Canal |
| | | | | | | | Contact Stabilization | Snake Crk. Canal |

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| City of Miami (30) | 47.0 | 47.0 | 470,000 | 166,000 | | | Activated Sludge | Atlantic Ocean |
| City of Miami Beach (19) | 40.0 | 17.0 | | 32,000 | | | None | Atlantic Ocean |
| Miami International Airport #1 (22) | 0.5 | 0.436 | 5,000 | 6,000 | | | Trickling Filter | Tamiami Canal |
| Miami International Airport #2 (21) | 0.5 | 0.346 | 5,000 | 5,000 | | | Imhalf Tank | Tamiami Canal |
| Miami International Lodge Motel | 0.022 | | | | | | Septic Tank Sand Filter | Tamiami Canal |
| Miami Lakes S/D (11) | 0.175 | 0.258 | 1,750 | 2,000 | | | Contact Stabilization | 138th St. Canal |
| Mobile Home Park | 0.035 | | | | | | Contact Stabilization | Drain-field |
| Mobile Homes Development | 0.050 | | | | | | Contact Stabilization | Little River |
| Monsr. Race Sr. High | 0.0275 | | | | | | Extended Aeration | Biscayne Canal |
| Nineteen Corp. Apts. | 0.012 | | | | | | Extended Aeration | Little River |

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| North Bay Village (18) | 0.8 | 0.45 | 8,000 | 2,600 | | | Activated Sludge | Biscayne Bay |
| City of North Miami (13) | 65.0 | 11.0 | 150,000 | 29,000 | | | Pretreatment | Atlantic Ocean |
| Myrtle Grove S/D (7) | 3.5 | 2.2 | 35,000 | 4,620 | | | Activated Sludge | Coral City Canal |
| Palm Springs North S/D | 0.445 | 0.305 | 4,450 | 4,000 | | | Activated Sludge | Snake Crk. Canal |
| Palm Springs General Hospital (5) | 0.050 | | | | | | Contact Stabilization | Little River |
| Palm Springs Village Shopping Center | 0.104 | | | | | | Extended Aeration | Canal C-7 |
| Pan American Hospital | 0.019 | | | | | | Extended Aeration | Tamiami Canal |
| Parkview Hospital | 0.012 | | | | | | Extended Aeration | Drainfield |
| Pool and Patio Apts. | 0.0164 | | | | | | Extended Aeration | Drainfield |
| Redland Farm Labor Camp (36) | 0.125 | 0.070 | 1,250 | 800 | | | Trickling Filter | Subsurface |
| Riverdale Estates S/D (1) | 0.350 | 0.49 | 3,500 | 955 | | | Trickling Filter | Snake Crk. Canal |

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| Royal Glades Nursing Home | 0.0075 | | | | | | Contact Stabilization | Golden Glades Canal |
| Royal Poinciana Motel | 0.0125 | | | | | | Contact Stabilization | Drainfield |
| Salvric, Inc. | 0.010 | | | | | | Contact Stabilization | Intra-coastal Waterway |
| Seaboard Ind. Park | 0.10 | | | | | | Extended Aeration | Little River |
| Shoreview Towers Apts. | 0.020 | | | | | | Rapid Bloc | Biscayne Bay |
| Skyline Motel | 0.015 | | | | | | Extended Aeration | Tamiami Canal |
| Snapper Crk. Park S/D (27) | 1.00 | 1.05 | 10,000 | 9,650 | | | Activated Sludge | Snapper Creek |
| South Canal Homes S/D (35) | 1.575 | 0.945 | 15,750 | 9,200 | | | Activated Sludge | Black Creek |
| South Dade Labor Camp (38) | 0.125 | 0.190 | 1,250 | 1,200 | | | Trickling Filter | Drainage Canal |
| South Miami Heights S/D (34) (Perrine) | 1.750 | 2.388 | 17,500 | 10,000 | | | Activated Sludge | Black Creek to Biscayne Bay |

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| Southern Estates S/D (24) (OpaLocka) | 0.525 | 0.475 | 5,250 | 1,685 | | | Trickling Filter | Snapper Creek to Biscayne Bay |
| Southern Florida Sanitarium & Hospital | 0.030 | | | | | | Extended Aeration | Drainfield |
| Sumars & Lift Porterhouse Steak Restaurant | 0.0101 | | | | | | Extended Aeration | Closed Sand Filter |
| Sun City (Belmont Park) (10) | 0.044 | 0.016 | 440 | 560 | | | Activated Sludge | Dumfounding Bay |
| Sutton Place Apts. | 0.026 | | | | | | Septic Tank | Drainfield |
| Tidewell Trailer Park | 0.034 | | | | | | Extended Aeration | Tamiami Canal |
| University of Miami (32) (South Campus) | 0.15 | | 1,500 | | | | Activated Sludge | Sand Filter then leached into ground |
| Veterans Admin. Hospital (28) (Coral Gables) | 0.300 | | 3,000 | | | | Trickling Filter | Coral Gables Canal to Biscayne Bay |

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| W. L. Walker Trailer Park | 0.0156 | | | | | | Septic Tank Sand Filter | Subsurface |
| West Coral Way S/D (Miami) (23) | 2.050 | 1.500 | 20,500 | 12,390 | | | Activated Sludge | Coral Gables Canal to Biscayne Bay |
| Westwood Lakes S/D (Miami) (25) | 1.645 | 2.600 | 16,450 | 5,970 | | | Trickling Filter | Snapper Creek Canal to Tamiami Canal to Biscayne Bay |
| Woody Bowling Alley | 0.022 | | | | | | Extended Aeration | Tamiami Canal to Miami River |
| Zayre Dept. Store | 0.015 | | | | | | Extended Aeration | Snake Creek Canal |
| Burdines (Hialeah) | | | | | | | | |
| Farm Stores Inc. (Miami) | | | | | | | | |

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| Florida Portland Cement | | | | | | | | |
| Golden Gate Motel | | 0.857 | | | | | | |
| Hialeah Ewing Plant (Hialeah) | | | | | | | Trickling Filter | Stream |
| Holiday Acres Mobile Home Park (Miami) | | | | | | | | |
| Kendall Complex | | | | | | | | |
| Li'l Abner Mobile Home Park (Miami) | | | | | | | Trickling Filter | |
| Newport Resort Motel | | 0.000117 | | | | | | |
| Red Lion Restaurant (Miami) | | | | | | | Septic Tank | Ocean Outfall |
| Royal Colonial Trailer Park (Miami) | | | | | | | | |

TABLE 3 (CONT'D)
DOMESTIC WASTE SOURCE INVENTORY
DADE COUNTY

| Name of Source & Location | Avg. Flow Design | Avg. Flow Actual | Population Equiv. | Population Served | Effluent BOD P.E. | Removal Efficiency % BOD | Type of Treatment | Receiving Stream |
|---|---|---|---|---|---|---|---|---|
| Sun City Hotel N. Miami | 0.085 | | | | | | Activated Sludge | Biscayne Bay |
| Sweden House (Miami) | | | | | | | | Drainfield |
| The Castaways (Miami Beach) | | | | | | | | |
| Valleydale Packers (Miami) | | | | | | | Extended Aeration | |
| Zippy Chocolate (Miami) | | | | | | | Extended Aeration | |

sluggish waters sewage pollution in the form of dissolved and suspended organic material, solids deposits and bacteria can accumulate to such concentration as to cause nuisance and health hazards.

Four collection systems having a combined flow of 75.0 mgd discharge into the Atlantic Ocean through three outfalls (Miami, Miami Beach, North Miami). North Miami discharges about 11 mgd of raw sewage through an 11,000 foot outfall. Miami Beach provides no treatment but discharges about 17 mgd of raw sewage through a 6900 foot outfall at a depth of about 40 feet. The City of Miami outfall discharges an estimated 47.0 mgd about 4600 feet off shore at a depth of only 16 feet. This plant provides intermediate activated sludge treatment prior to discharges. No figures are available as to the treatment efficiency provided by this plant.

Three systems discharge an estimated 0.6 mgd to the intracoastal waterway and Biscayne Bay and, finally, three systems discharge an estimated 0.5 mgd to the ground through drain fields. A summary of the flows and receiving streams major discharges is given in Table 4.

Primary treatment plants, which consist essentially of settling tanks and sludge digesters, can remove most settleable solids, about one-third of the BOD, and approximatedly 50 percent of the bacteria. Secondary plants include secondary biological treatment units, such as oxidation lagoons, trickling filters, or activated sludge systems. Such plants can remove 90 to 95 percent of the BOD, suspended solids and coliform bacteria. Chlorination facilities for disinfection of properly treated sewage can destroy more than 99 percent of the sewage bacteria. To accomplish these reductions, however, treatment facilities must be properly designed, have adequate operating funds, and be skillfully operated.

TABLE 4

SUMMARY OF MAJOR WASTE SOURCES BY DRAINAGE BASIN

| Name of Watershed | Estimated Flow (mgd) | Number of Plants |
|---|---|---|
| Snake Creek | 6.4 | 8 |
| Biscayne & Little River | 1.7 | 5 |
| Miami | 1.0 | 3 |
| Coral Gables | 4.2 | 3 |
| Snapper Creek | 4.3 | 4 |
| Black Creek | 3.5 | 3 |
| South Bay | 3.7 | 4 |
| TOTAL TO CANALS | 24.8 | 30 |
| Atlantic Ocean | 75.0 | 4 |
| Intracoastal Waterway | .6 | 3 |
| Ground | .5 | 3 |
| TOTALS | 100.1 | 40 |

Septic Tanks

The Hollis Report[7] estimates that there are 143,000 septic tank installations in Dade County serving an estimated half million people. Based on 1970 population figures and estimated population served by treatment facilities, as many as 837,000 people may be on septic tanks or are discharging raw sewage. This represents 58% of the 1970 population. The shallowness of the water table, porosity of the shallow aquifer and the number of private wells used for water supply and lawn irrigation present opportunities for contamination and constitute a definite health hazard.

Conclusions developed from a comparative study of canals in areas served by sewers and by septic tanks state that higher BOD and lower D.O. in the lower levels and luxuriant algae growth in the surface layer of canals in the septic tank area can be attributed to septic tank effluent.[8] Thus, there is evidence that, in addition to causing a health hazard, septic tanks may contribute to the total load of pollution material carried by the waterways in their drainage area.

Package Units

There are about 74 plants serving apartment houses, trailer parks and shopping centers which are small extended aeration package units or septic tanks. Kiker[9], in work done on small plants throughout the State of Florida, including Dade County, concluded that these

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(7) Notations of the Ad Hoc Committee on Environmental Determinants in the tri-county area of Dade, Broward and Palm Beach Counties, M. D. Hollis, Chairman, May 1970.

(8) Pollution of Canals by Septic Tanks, Master Thesis by Thomas Paul Jackivicz, University of Miami, June 1969.

(9) Kiker, J. E., Jr., "Package and Subdivision Sewage Treatment Plants," Journal WPCF, Vol. 32, No. 8, August 1960.

package units functioned properly only if operation and maintenance was adequate and that in most cases it was not. Of 14 plants tested, only three met the current State requirement of 90% BOD reduction.

In most instances, the small package plants discharge to the nearest convenient waterway. Furthermore, they usually serve facilities with a highly mobile and variable population, a factor which contributes to poor performance. No estimate can be made of the total load of pollution from these sources since performance and loading data are not reported in the inventory, but the number of plants in this category would suggest they may be a significant source of pollution.

## INDUSTRIAL WASTES

No data are presently available to FWQA concerning the identity, number or location of industrial waste discharges, or the load or effects on water quality of such discharges.

## SUMMARY

Due to incomplete waste source data, only general conclusions can be reached.

Only about one-third of the resident population is known to be served by major sewage collection and treatment facilities. Of the 40 major facilities, at least eight plants are known to be hydraulically overloaded.

Over one million people in Dade County are served by septic tanks and small package plants for the disposal of sewage and domestic wastes.

An accurate inventory of all municipal and industrial waste sources and a determination of the waste load which each contributes to the waterways and their treatment plant performance are a first and very basic requirement.

## WATER QUALITY STANDARDS

Florida State water quality standards were approved and adopted by the Secretary of the Interior on January 17, 1969. Under sections 28-5.21 and 28-5.09 of the Rules of the Florida Air and Water Pollution Control Commission, all waters in Dade County are classified as Class III: Recreation Propagation and Management of Fish and Wildlife, except the Miami River which is Class V: Navigation, Utility and Industrial use. Section 28-5.01 expresses the "intent of the State of Florida to review Class V stream classifications periodically as often as necessary, and as water quality of such areas improves, hearings will be held and reclassification shall be established. It is expected that in all instances, presently classified as Class V waters, there shall be decided and definitive enhancement not later than January 1, 1973."

A summary of Class III water quality criteria from Section 28-5.09 is as follows:

1. Wastes shall be effectively treated,
2. pH not more than $\pm$ 1.0 unit from normal,
3. dissolved oxygen not artificially depressed below 4.0 mg/l,
4. coliform bacteria not to exceed 1,000 per 100 ml as a monthly average.
5. free from toxic substances,
6. free from nuisance-causing discharges,
7. turbidity shall not exceed 50 units above normal,
8. temperature shall not cause damage to the aquatic environment.

Additionally from Section 28-5.04(3), the presence of nitrates and phosphates in any amounts shall be suspected of degrading water quality.

Effluent standards under Section 28-5.04 require a minimum of 90% treatment of organic material for both municipal and industrial wastes. Additional treatment may be required as needed to meet water quality criteria of the receiving waters.

The Dade County Pollution Control Ordinance (No. 67-95 dated 12-19-67) Section 24-11, as amended, contains the following criteria: dissolved oxygen must be 5.0 mg/l for at least 10 hours per day but never less than 4.0 mg/l; and coliform bacteria are limited to 1000/100 ml without regard to monthly averages. No distinction is made in classification of waters and all waters are subject to the same quality criteria.

Section 24-13 of the Dade County Ordinance added by Ordinance No. 70-44 (06-02-70) concerns septic tanks. "Where public water supply is used, no septic tank shall be installed . . . where greater than 1500 gallons/day per unsubmerged acre of land will be generated by the actual or projected use." Where public water supplies are not used the allowable discharge shall not exceed 750 gallons/acre/day.

# WATER QUALITY

## GENERAL

Sewage contains a variety of obnoxious constituents which can damage water quality and restrict its use. Sewage contains astronomical numbers of intestinal bacteria which were released in man's excretions. Some of these bacteria may be pathogens which can infect man with a variety of diseases.

Oxygen-demanding materials found in sewage can limit or destroy fish, shellfish, fish food organisms, and other desirable aquatic life by removing dissolved oxygen from the water.

The oxygen demand of sewage, as measured by the five-day biochemical oxygen demand (BOD) test, indicates their potential for reducing the dissolved oxygen content of the waters. The coliform bacteria content of raw and treated sewage discharged to a water-course indicates the density of sewage associated bacteria, which may include disease-producing organisms.

## NORTHERN DADE COUNTY CANALS

Most of the data discussed in this report were collected by the Dade County Pollution Control Department during 1968 and 1969. Additional data were collected by the Federal Water Quality Administration, Lower Florida Estuary Study.

The mileages reported for the locations of sampling stations, intersecting canals, and sewage treatment plants are approximate. Distances along the canals were measured from the mouth of the canal when possible.

Canals reported to have serious pollution problems are discussed in detail in this section. They are: Miami River, Coral Gables Waterway, Snapper Creek, Biscayne Canal, Tamiami Canal, Little River Canal, Snake Creek Canal, and Oleta River.[10] Relatively unpolluted canals discharging into lower Biscayne Bay are discussed briefly. All canals discussed except the Miami River are classified for Recreation and Propagation and Management of Fish and Wildlife (Class II).

Sampling station locations are presented in Figure 1 and Appendix A-1 and a summary of the Federal Water Quality Administration data is presented in Appendix A-2.

Coral Gables Waterway

The Coral Gables Waterway begins at the Tamiami Canal and extends approximately 7.2 miles to the northern part of middle Biscayne Bay. Approximately 1.2 miles above the mouth the canal branches into two channels which join again at mile 2.7. The northern branch of the canal is 1.5 miles long and the southerr branch has a length of 2.5 miles. At mile 3.9, a salinity dam near Red Road halts the passage of boats up the canal. West of the dam the waters of the canal are fresh and unaffected by the tide; east of the dam, the canal is a tidal estuary.

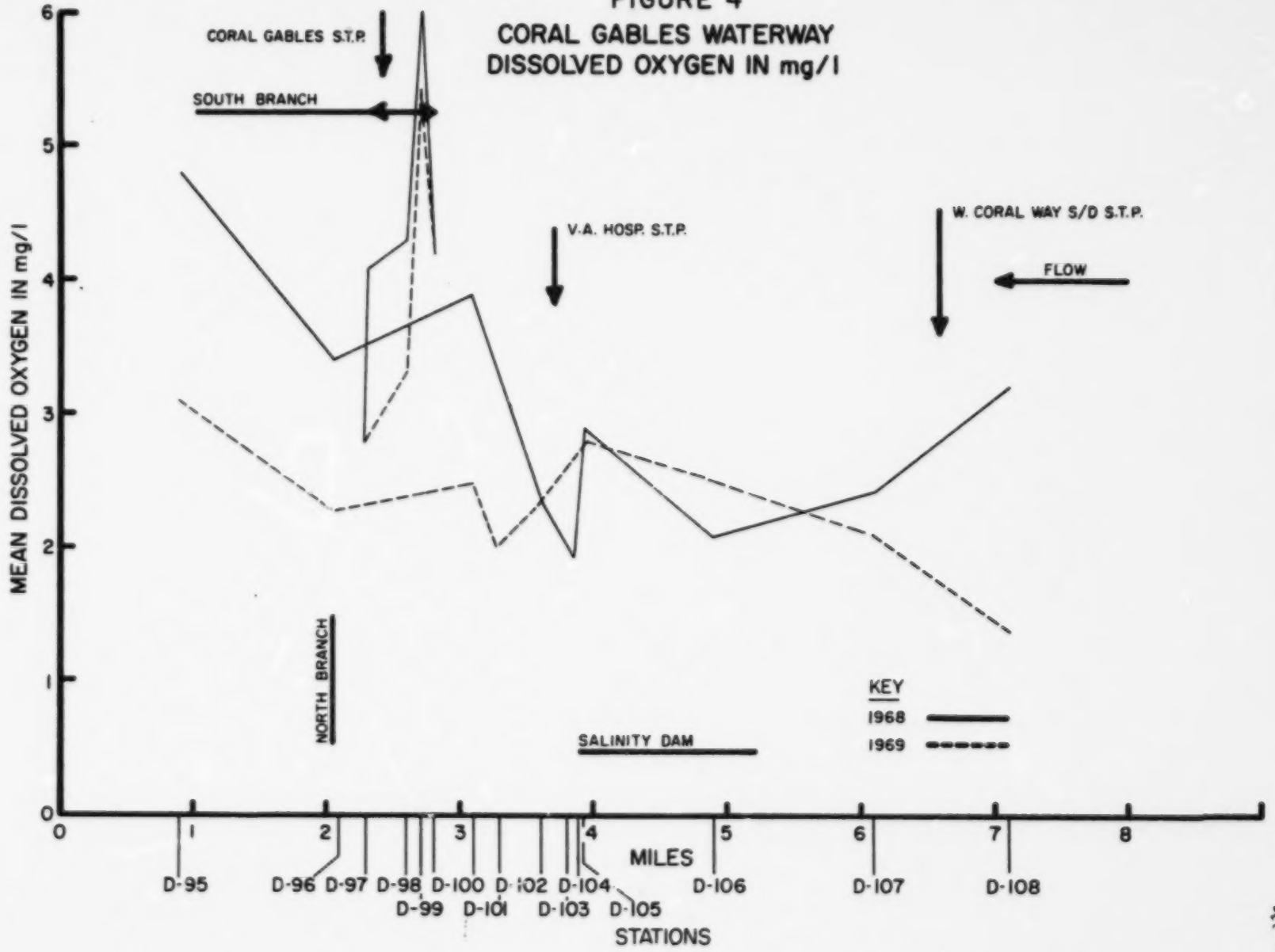
In 1968, all the sampling stations in the north branch and main canal had mean dissolved oxygen (D.O.) concentrations less than the Federal, State, and local standards of 4 mg/l except one--D95, at mile 0.9. The mean D.O. concentration at this station was 4.8 mg/l and the minimum was 2.0 mg/l. The lowest mean D.O. concentration of 1.9 mg/l occurred at Station D104, just below the salinity dam. This station is 0.2 miles

(10) Letter dated July 23, 1970, Paul Leach to Vince Patton.

upstream of the Veterans Administration Hospital Sewage Treatment Plant (S.T.P.) which discharges 0.3 million gallons per day (mgd) of treated sewage into the canal. This reach of the canal is affected by the tide, and waste discharges would be distributed both up and downstream of their points of entry. The mean D.O. for 1968 of water entering from the Tamiami Canal was 3.2 mg/l, measured at Station D108. Downstream of this station 1.5 mgd from the West Coral Way Subdivision enter the Coral Gables Waterway. Figure 4 illustrates the D.O. depression below this discharge. The critical point in this reach occurs at mile 4.9, where the mean D.O. was 2.1 mg/l in 1968. D.O. concentrations in the south branch of the Coral Gables Waterway were considerably higher than in the north branch. The highest mean concentration was 6.0 mg/l, in 1968, at Station D99, which is in Student Lake on the University of Miami campus. The minimum concentration at this station was 2.8 mg/l, which is also in violation of Federal, State, and local standards. The City of Coral Gables Sewage Treatment Plant discharges 2.4 mgd of treated effluent into the south branch of the canal.

In general, mean D.O. concentrations in 1969 were lower than they were in 1968. At most stations, the 1969 values were about 1.0 mg/l lower, indicating a deteriorating water quality. In 1969, the mean D.O. of the water entering the Coral Gables Waterway from the Tamiami Canal was 1.4 mg/l, which was considerably lower than the average concentration of this water in 1968. In the fresh water reach of the canal, the D.O. was 2.8 mg/l at Station D105 west of the salinity dam. The data for 1969 do not reflect the effect of the West Coral Way Subdivision Sewage Treatment Plant. D.O. depletions due to discharges from the Veterans Administration Hospital S.T.P. and the City of Coral Gables S.T.P. are clearly depicted in Figure 4. The lowest mean D.O. concentration in 1969, 2.0 mg/l, occurred at Station D102, which is at mile 3.3. The D.O. at this station in 1969 never exceeded 4.0 mg/l.

# FIGURE 4
## CORAL GABLES WATERWAY
## DISSOLVED OXYGEN IN mg/l



The five-day biochemical oxygen demand (BOD) concentrations in the Coral Gables Waterway were significantly greater in 1969 than 1968, again indicating an increase in the quantity of waste discharged to the waterway. Extremely high mean BOD concentrations of 9.2 mg/l in 1968 and 8.3 mg/l in 1969 were observed at Station D107, approximately 0.5 mile downstream of the West Coral Way Subdivision S.T.P. In the estuarine reach of the waterway, the mean BOD concentration increased upstream of both sewage treatment plants in this reach (Figure 5).

Upstream of the salinity dam very high coliform bacteria densities were observed below the West Coral Gables S.T.P. A mean density of 104,600 MPN per 100 ml in 1968 and a mean density of 46,400 MPN per 100 ml in 1969 were observed at this location.(Note) Excessive bacterial densities were also observed in the vicinity of the two sewage treatment plants located downstream of the salinity dam. Bacterial densities in 1969 were generally lower than those in 1968. A profile of total coliform bacteria concentrations in the Coral Gables Waterway is shown in Figure 6. All stations in the Coral Gables Waterway had total coliform densities which violated the federally adopted State of Florida Water Quality Standards of 1000 MPN per 100 ml, as well as those of Dade County during most times in 1968 and 1969.

Miami River Canal

The Miami River Canal flows from Lake Okeechobee in a southeasterly direction through the water conservation area into upper Biscayne Bay just north of the Rickenbacker Causeway. The section of the waterway discussed in this report is the lower 15 miles. A salinity dam at mile 5.2 near N. W. 36th Street regulates flows and prevents saltwater intrusion. The river below the dam is a tidal estuary.

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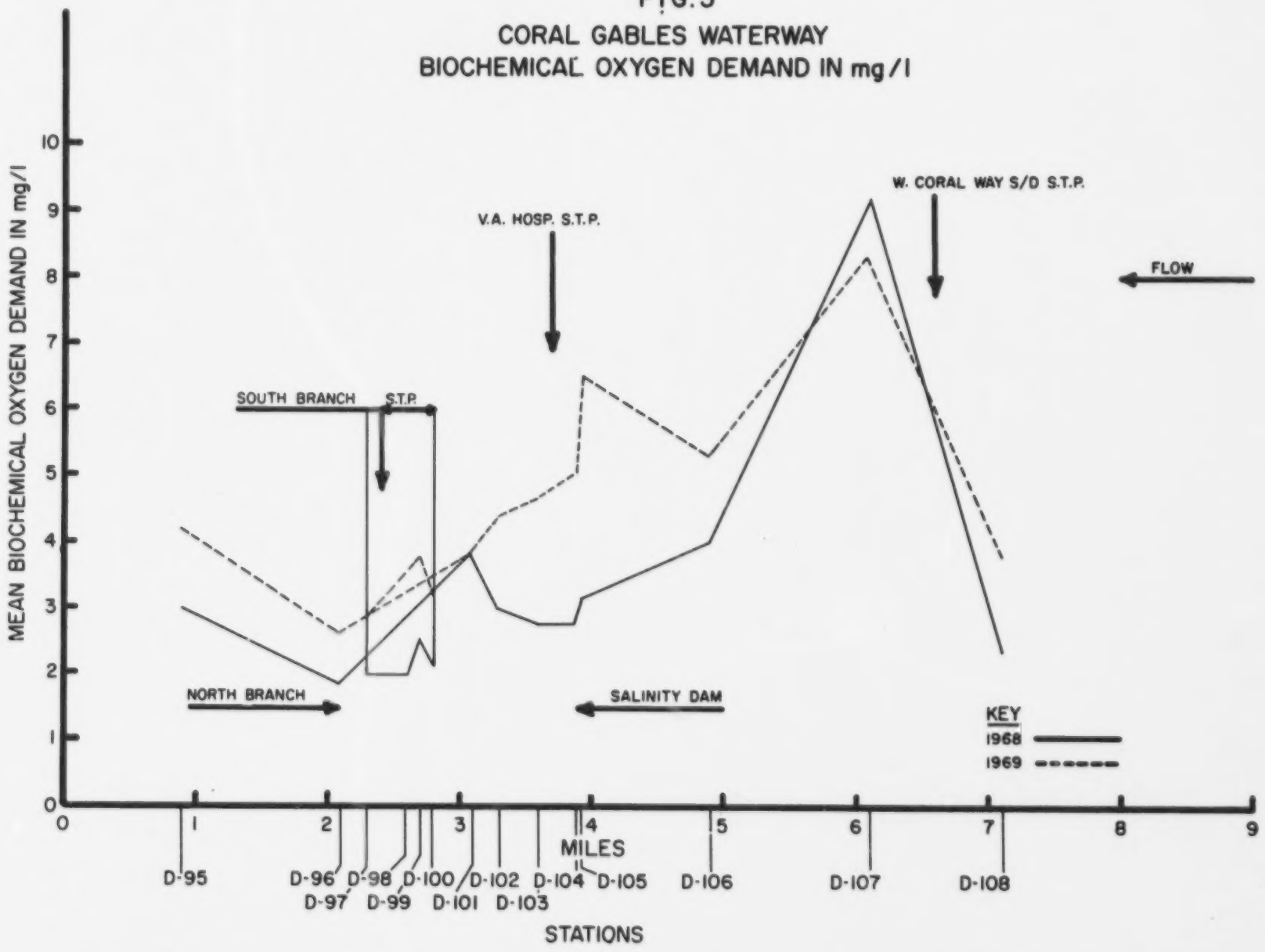
Note: Coliform bacteria means are calculated and reported by Dade County Pollution Control as arithmetic average rather than the more customary logarithemic average.

FIG. 5

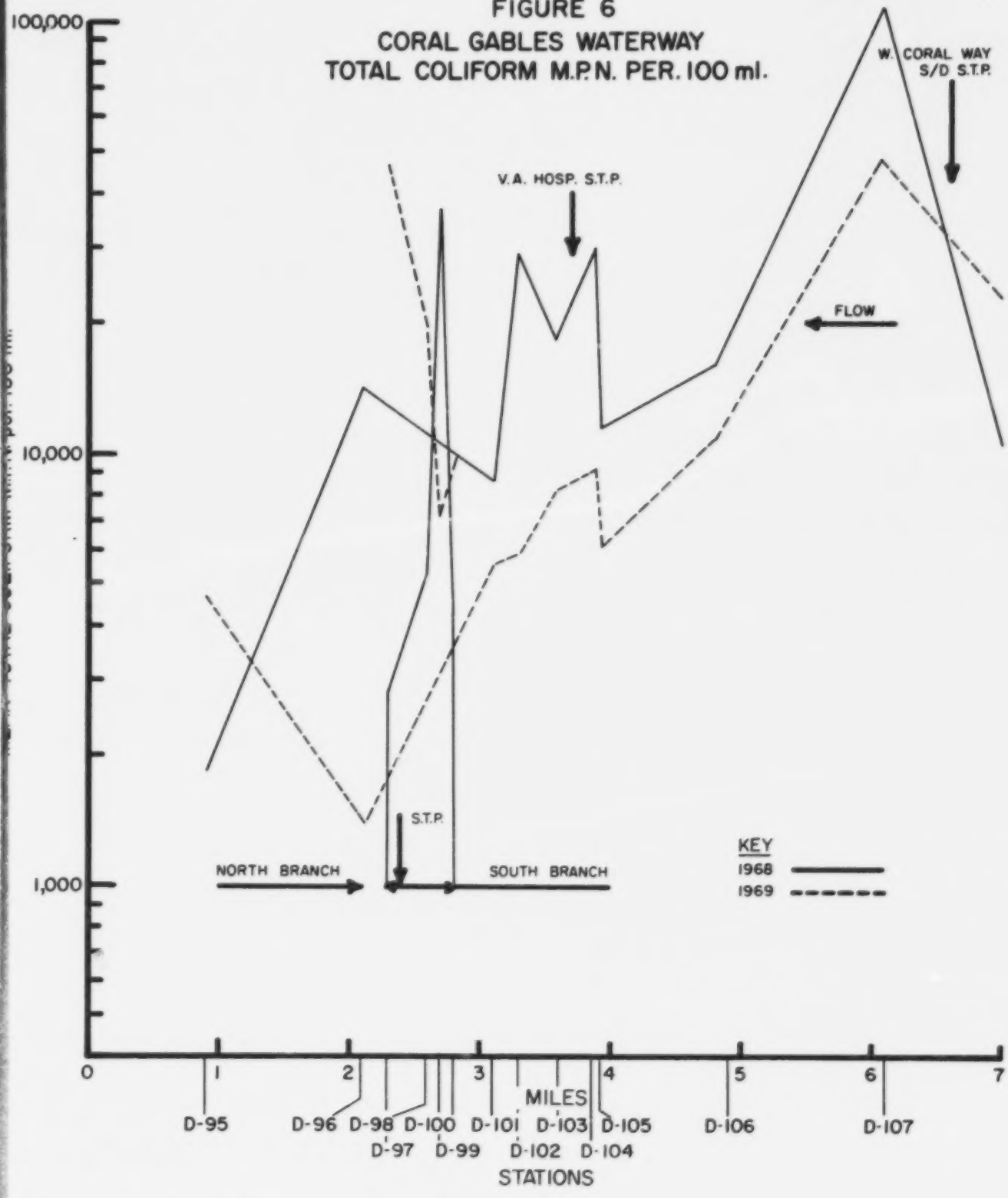
CORAL GABLES WATERWAY

BIOCHEMICAL OXYGEN DEMAND IN mg/l




25 L

# FIGURE 6
## CORAL GABLES WATERWAY
## TOTAL COLIFORM M.P.N. PER. 100 ml.



The Miami River Canal is polluted by the raw sewage discharged from numerous apartments, private homes, industrial and commercial establishments, and from houseboats and live-on boats. A Dade County Pollution Control report (11) indicates that more than 910,000 gallons per day (gpd) of raw sewage is discharged to the waterway. In addition, 22,000 gpd finds its way into the river from drainfields and 22,600 gpd is discharged by houseboats and live-on boats. The report also states that 145,000 gpd of treated effluent is discharged by five small sewage treatment plants and that during storms 1,764 million gallons per day of storm water runoff reaches the river from 86 storm sewer outfalls.

As shown in Figure 7, dissolved oxygen (D.O.) concentrations upstream of the salinity dam were extremely low, and the concentrations observed in 1968 and 1969 were approximately the same. Mean D.O. concentrations in this reach ranged from 1.6 to 1.1 mg/l. Below the salinity dam, the lowest mean D.O. concentrations were observed at Station D138, which is just downstream of the dam. Mean concentrations at this location were 1.3 mg/l in 1968 and 1.0 mg/l in 1969. The maximum concentrations observed at this location were 3.6 mg/l in 1968 and 2.0 mg/l in 1969. The highest mean D.O. concentrations in the river, 2.6 mg/l in 1968 and 2.5 mg/l in 1969, were observed at Station D109 near the mouth. Dissolved oxygen in the Miami River was also measured by the FWQA. An average concentration of 5.6 mg/l was found at Station 14, near the mouth and of 2.8 mg/l at Station 29 downstream from the Comfort Canal entrance. All mean D.O. concentrations in the Miami River were well below the 4.0 mg/l standard, indicating that an extremely serious pollution

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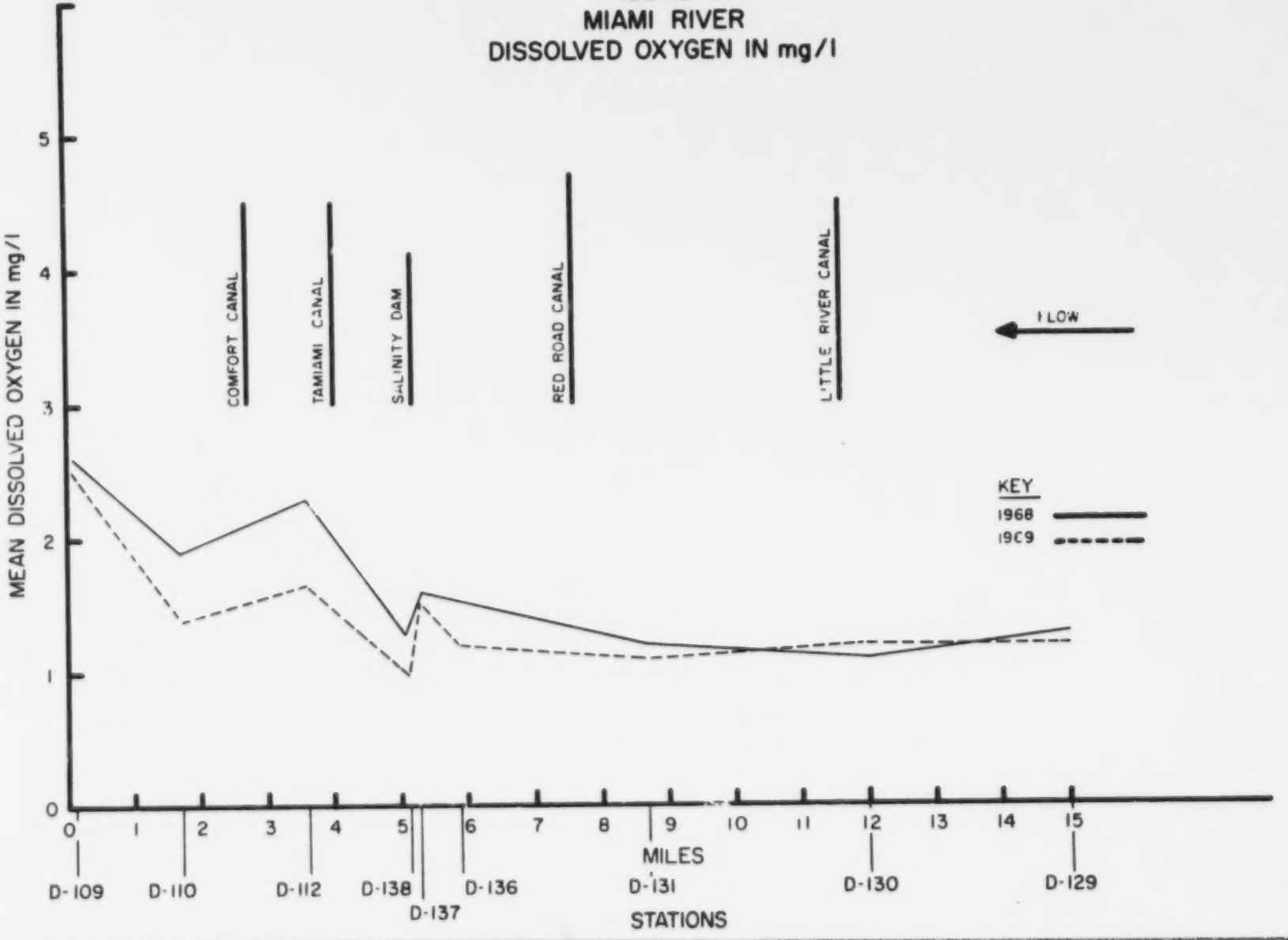
(11) Schmitx, J. J., "Report on Water Conditions and Pollution Sources of the Miami River and its Tributaries", Dade County Pollution Control, August 8, 1969.

FIGURE 7
MIAMI RIVER
DISSOLVED OXYGEN IN mg/l



problem exists. The Federal-State classification for the Miami River is for navigation, utility and industrial use and is required only to be aerobic. However, the Dade County standards make no such exception and its criteria are being violated.

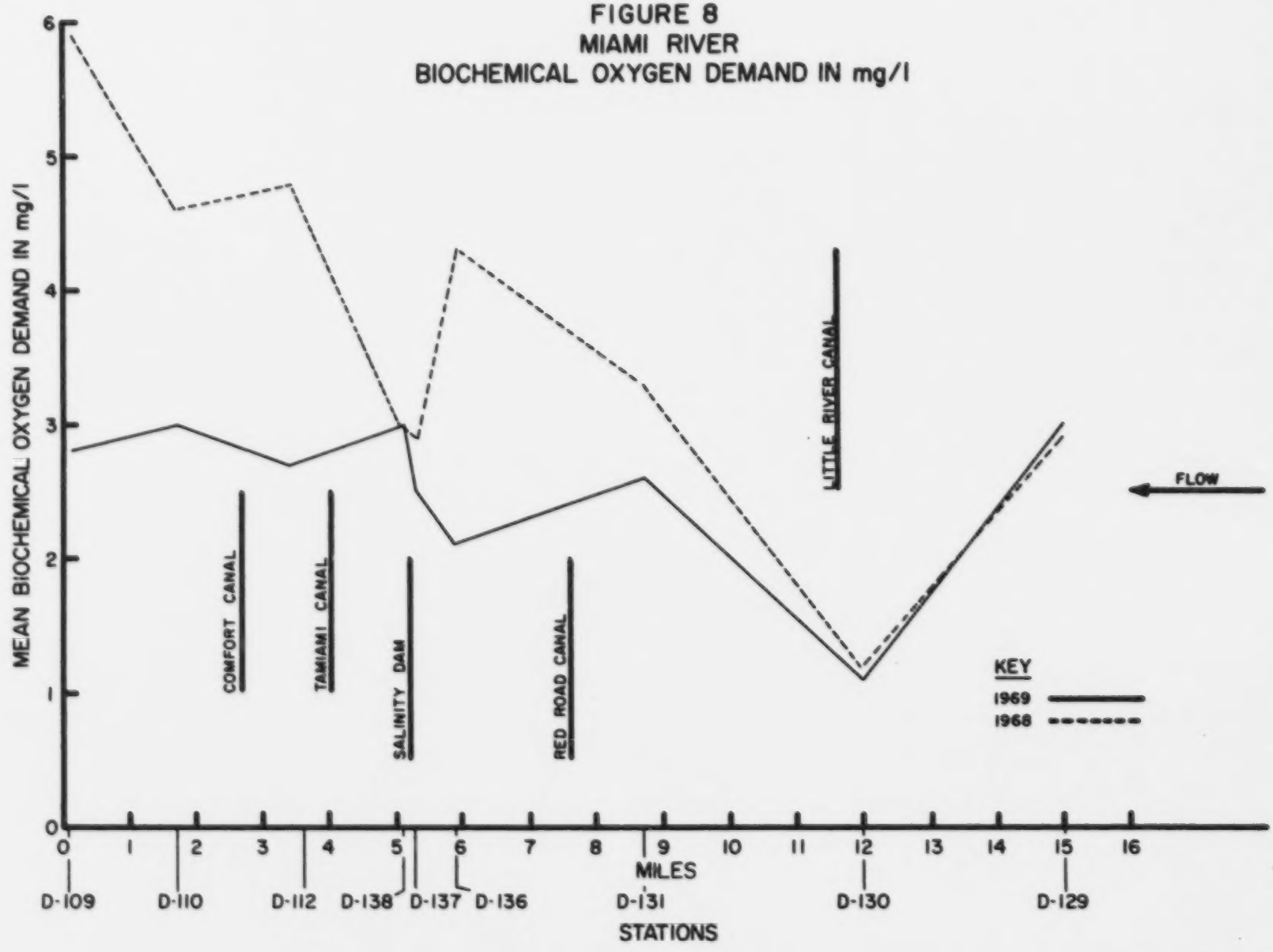
Concentrations of biochemical oxygen demand were greater in 1969 than in 1968. The highest mean value in the fresh water reach of the canal was 4.3 mg/l in 1969 at Station D136, mile 0.7, upstream from the salinity dam. Downstream of the dam the highest mean of 5.9 mg/l in 1969 was found at the mouth of the river. The BOD profile for the Miami River is shown in Figure 8.

The FWQA study found an average of 1.2 mg/l of BOD at the mouth and 1.0 mg/l downstream from the Comfort Canal entrance.

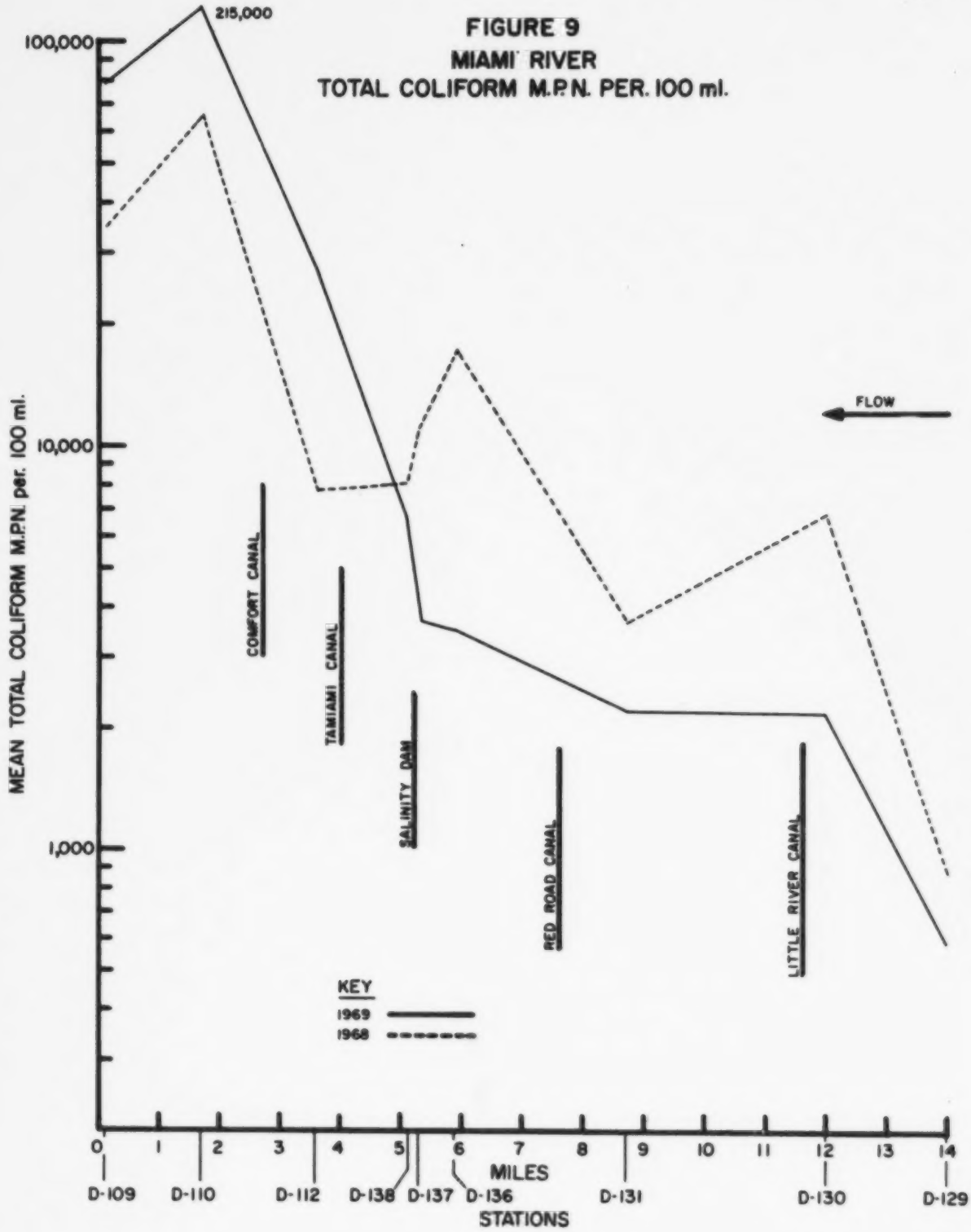
In 1969 all mean total coliform concentrations in the fresh water reach of the river exceeded the 1968 concentrations and in the saline reach of the river the reverse was observed. Most mean total coliform densities violated the 1000 MPN per 100 ml standard, with the exception of Station D129, mile 15, which were 869 MPN per 100 ml in 1969 and 590 MPN per 100 in 1968. The highest mean bacterial densities occurred at Station D110, mile 1.7, and they were 215,000 PMN per 100 ml in 1969 and 66,000 PMN per 100 ml in 1968 (figure 9).

The Miami River is so acutely polluted that if it were backpumped as proposed it could cause serious pollution problems in the water conservation areas. Water from the river also serves to recharge the groundwater supply and pollution of groundwater could eventually occur if water quality in this canal remains the same or deteriorates further.

FIGURE 8
MIAMI RIVER
BIOCHEMICAL OXYGEN DEMAND IN mg/l



# FIGURE 9
## MIAMI RIVER
## TOTAL COLIFORM M.P.N. PER. 100 ml.



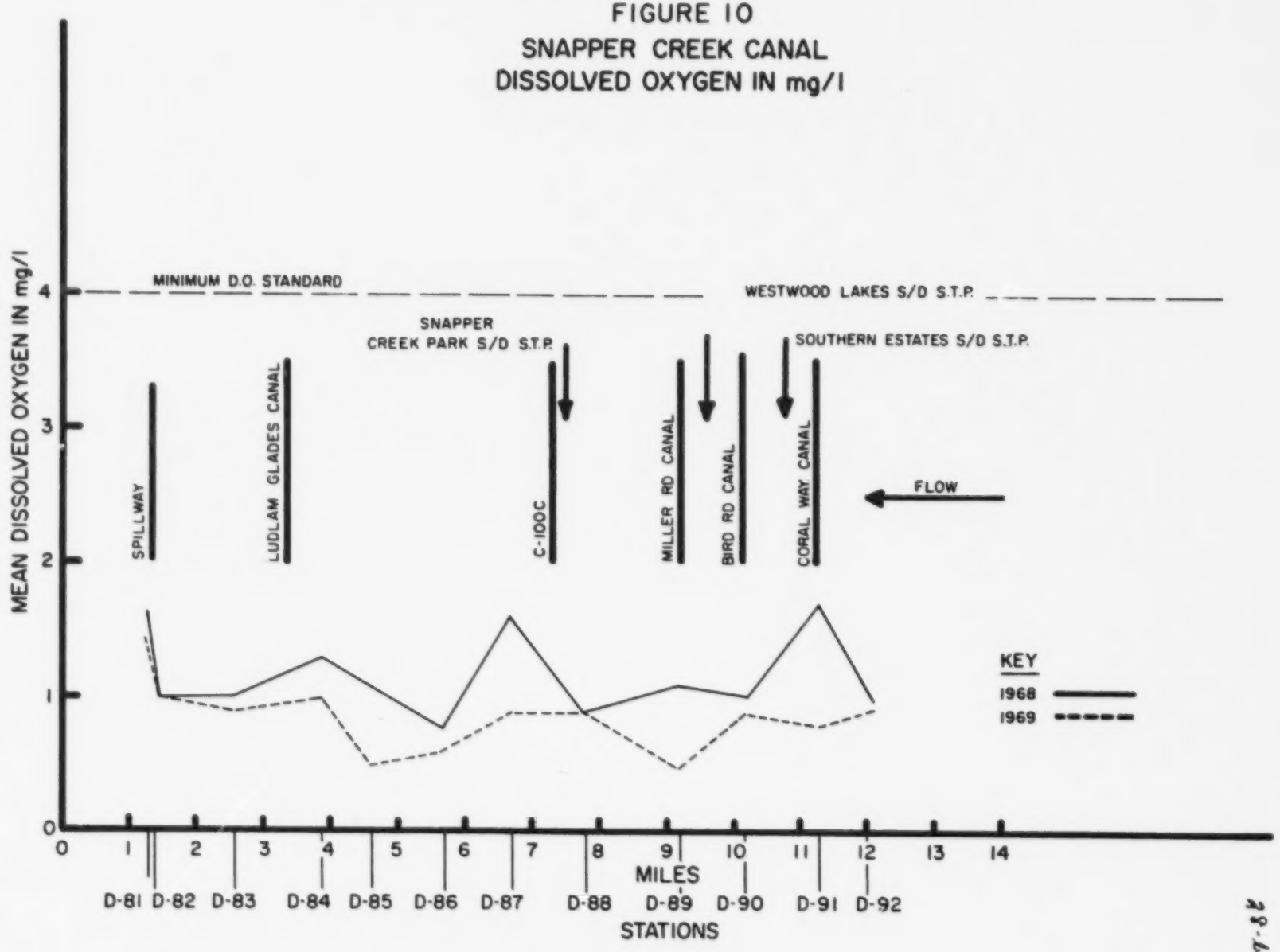
Snapper Creek Canal

The Snapper Creek Canal extends 12 miles from the Tamiami Canal to central Biscayne Bay. A spillway, located at Red Road approximately 1.3 miles above the mouth of the canal, controls flows in the canal and prevents saltwater intrusion. Three major sewage treatment plants discharge into the Snapper Creek Canal. The largest discharges 2.6 million gallons per day (mgd) and serves the Westwood Lake Subdivision. The Snapper Creek Park Subdivision S.T.P. discharges 1.05 mgd of effluent into the canal and the Southern Estates subdivision plant discharges 0.475 mgd.

Mean dissolved oxygen concentrations in Snapper Creek were extremely low during the 1968-1969 study period. The 1968 mean values ranged from 1.7 to 0.8 mg/l. Conditions were even worse in 1969, when the mean D.O. concentration ranged from 1.4 to 0.5 mg/l, with only one station having a mean D.O. concentration greater than 1.0 mg/l. The mean D.O. at the mouth of the canal was 5.0 mg/l, and 2.7 mg/l at Station 30, mile 2.6, during the FWQA study. The D.O. profile of the Snapper Creek Canal is presented in Figure 10. Dissolved oxygen concentrations violate both Federal-State and county standards.

As would be expected, the biochemical oxygen demand (BOD) concentrations in the Snapper Creek Canal were extremely high and the mean values in 1969 generally exceeded those in 1968 (Figure 11). The highest mean BOD concentrations of 4.1 mg/l in 1968 and 4.5 mg/l in 1969 occurred at Station D87, mile 6.7, just downstream of the three waste discharges. Mean BOD values decreased from D87, mile 6.7, to D85, mile 4.6, and then increased again downstream. Mean BOD concentrations measured during the FWQA study were 1.2 mg/l at the mouth and 3.9 mg/l at mile 2.6. All mean coliform densities exceeded 1000 MPN per 100 ml (Figure 12).

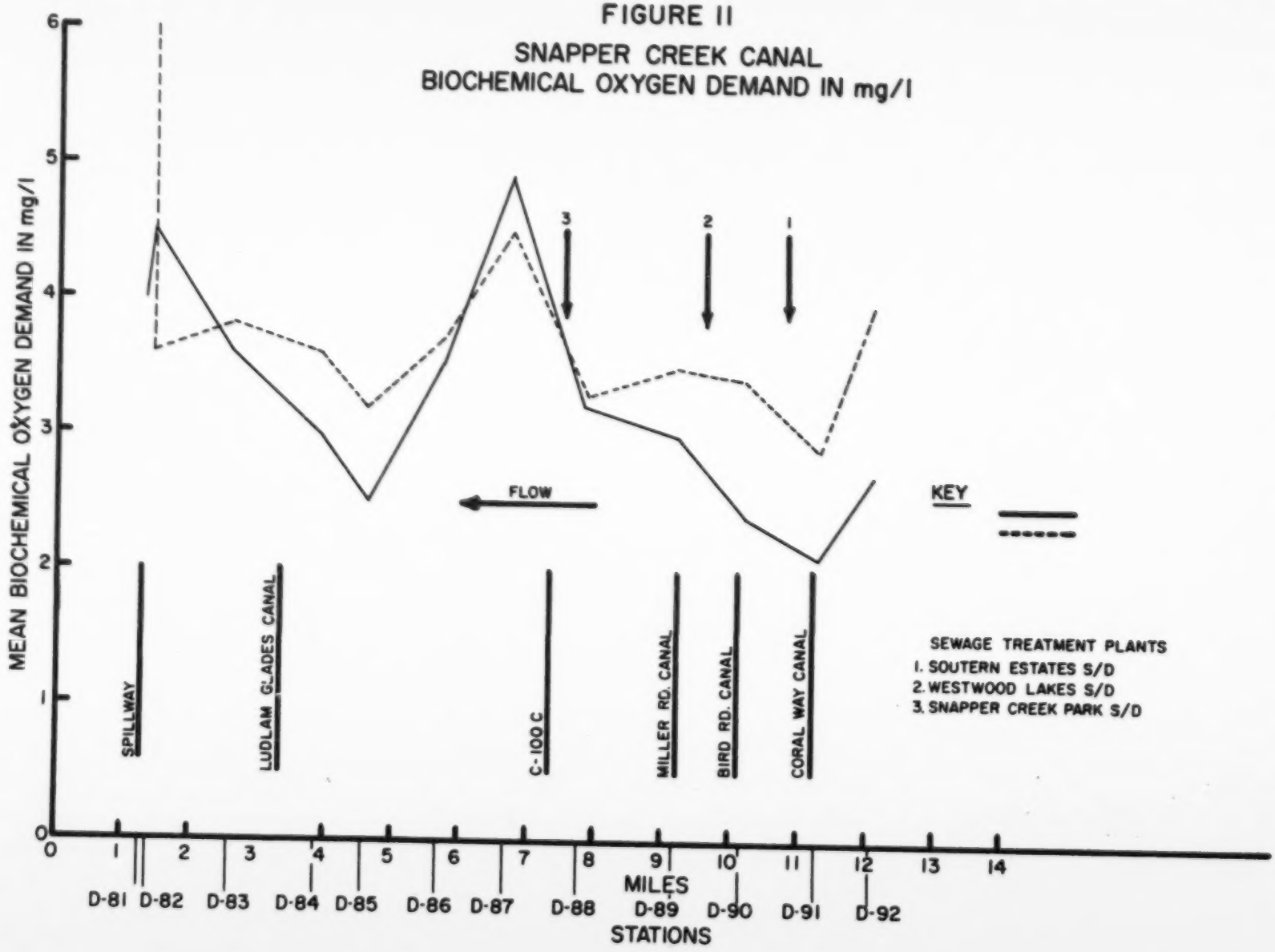
FIGURE 10
SNAPPER CREEK CANAL
DISSOLVED OXYGEN IN mg/l



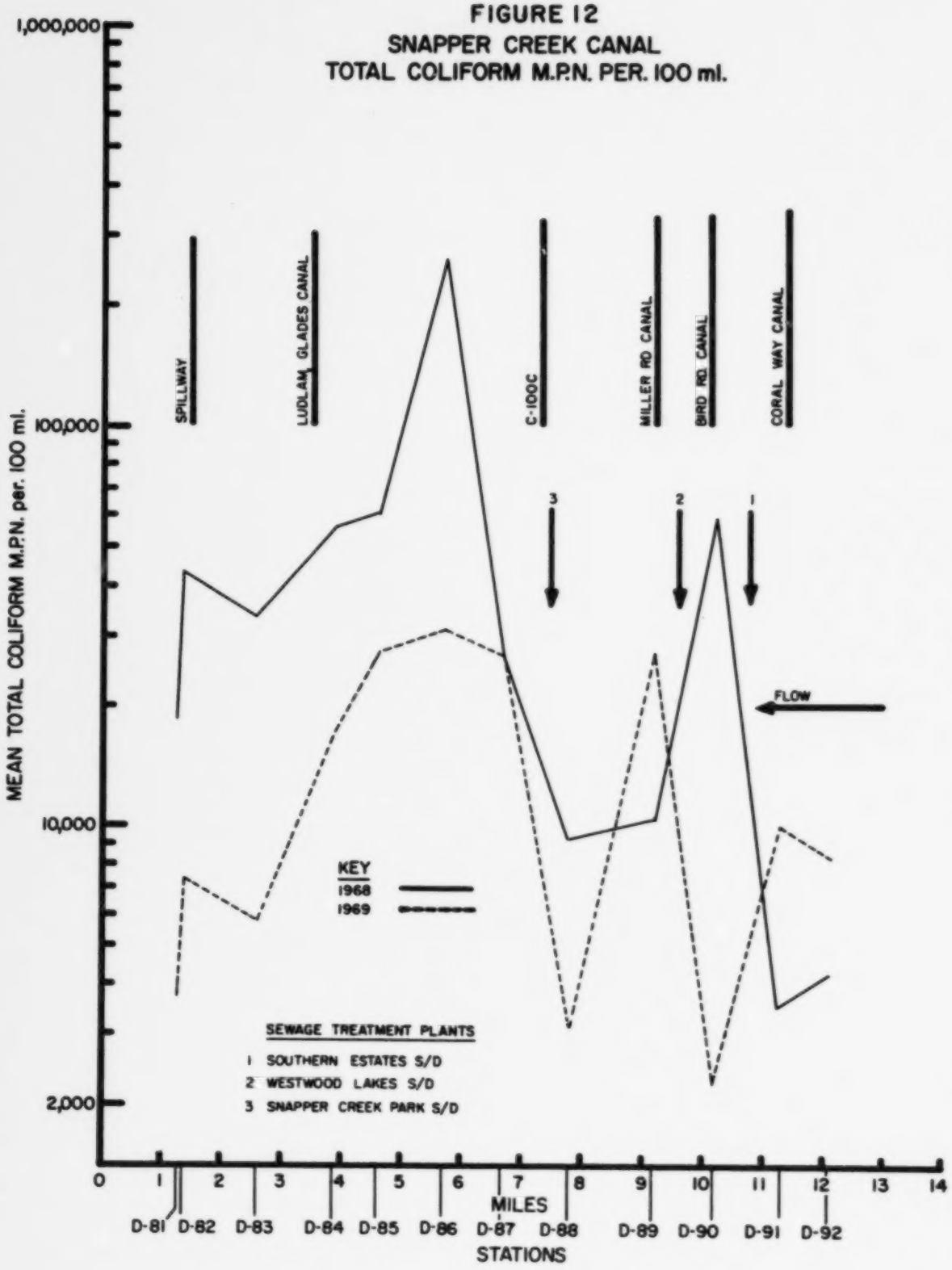

28-A

FIGURE II

SNAPPER CREEK CANAL
BIOCHEMICAL OXYGEN DEMAND IN mg/l



# FIGURE 12
## SNAPPER CREEK CANAL
## TOTAL COLIFORM M.P.N. PER. 100 ml.



Biscayne and Opa Locka Canals

The Biscayne Canal has a length of approximately 12 miles and flows from the Palmetto Expressway to upper Biscayne Bay between the Broad and 79th Street Causeways. The Opa Locka Canal extends from the Palmetto Expressway to the Biscayne Canal and has a length of approximately 7 miles. The only major sewage treatment plant discharging into the Biscayne Canal is the Dade County Port Authority S.T.P., which has a design flow of 1.0 mgd. There are no known major discharges to the Opa Locka Canal. A spillway is located on the Biscayne Canal, five miles upstream of the mouth.

The dissolved oxygen profiles for the Biscayne and Opa Locka Canals are presented in Figure 13. The mean 1968 D.O. concentrations in the Biscayne Canal were greater than 4.0 mg/l, with the exception of a concentration of 3.8 mg/l below the spillway. In 1969, only three stations had concentrations equal to or greater than 4.0 mg/l. This represents a drastic deterioration in the quality of the water. Water quality also deteriorated between 1968 and 1969 in the Opa Locka Canal based on D.O. The FWQA study found an average D.O. concentration of 6.0 mg/l and an average BOD concentration of 1.2 mg/l at Station 17 near the mouth of the Biscayne Canal. At Station 41, just upstream of the spillway, the mean D.O. was 8.3 mg/l and the mean BOD was 3.1 mg/l.

At most stations the mean BOD was greater in 1969 than in 1968 (Figure 14). An extremely high mean BOD of 7.9 mg/l in 1969 was found at Station D139 just upstream of the spillway in the Biscayne Canal. A high mean BOD of 7.7 mg/l in 1969 was observed at Station D149, mile 10.1, in the Opa Locka Canal.

FIG. 13
BISCAYNE & OPA LOCKA CANAL
DISSOLVED OXYGEN IN mg/l

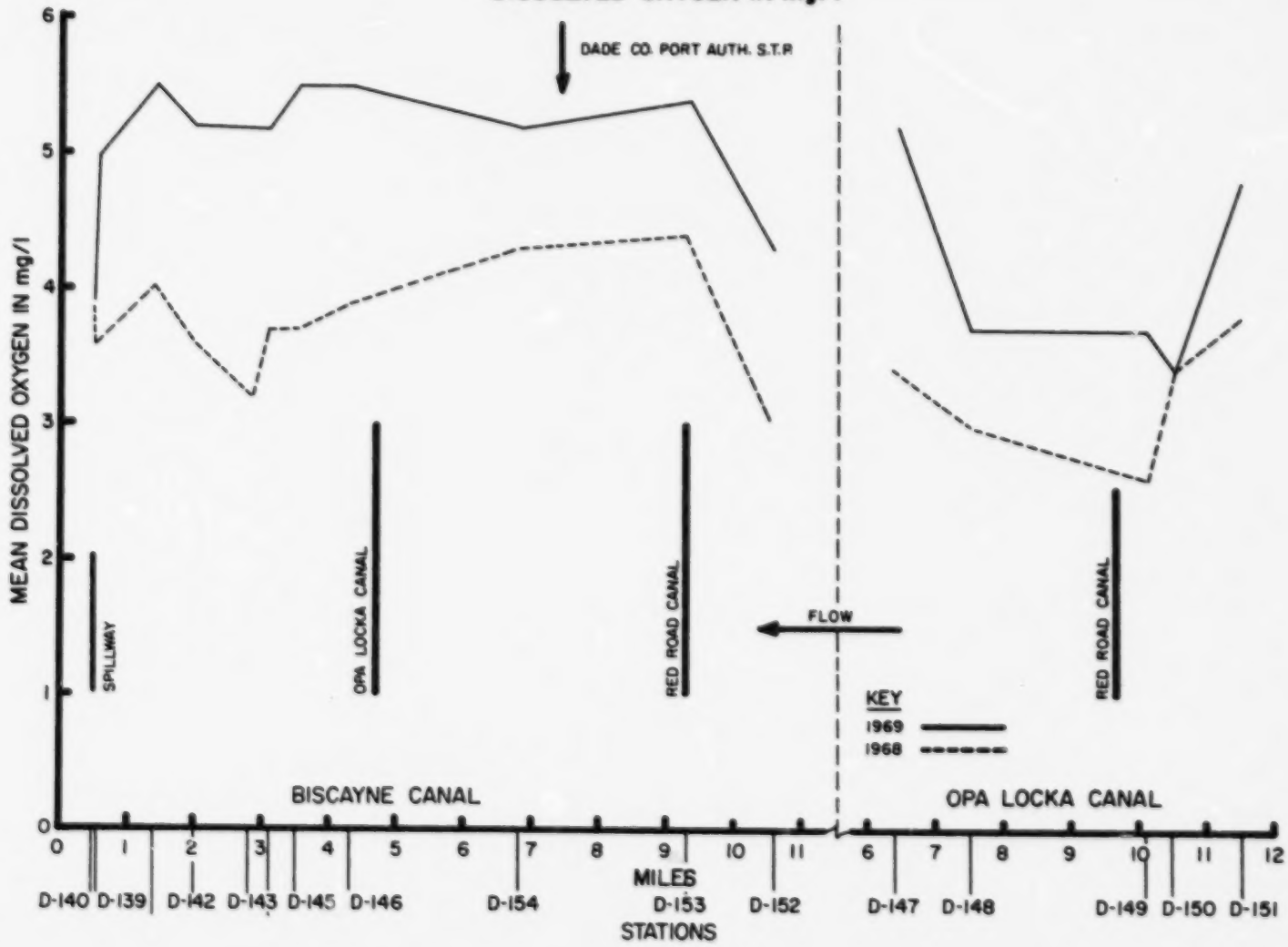
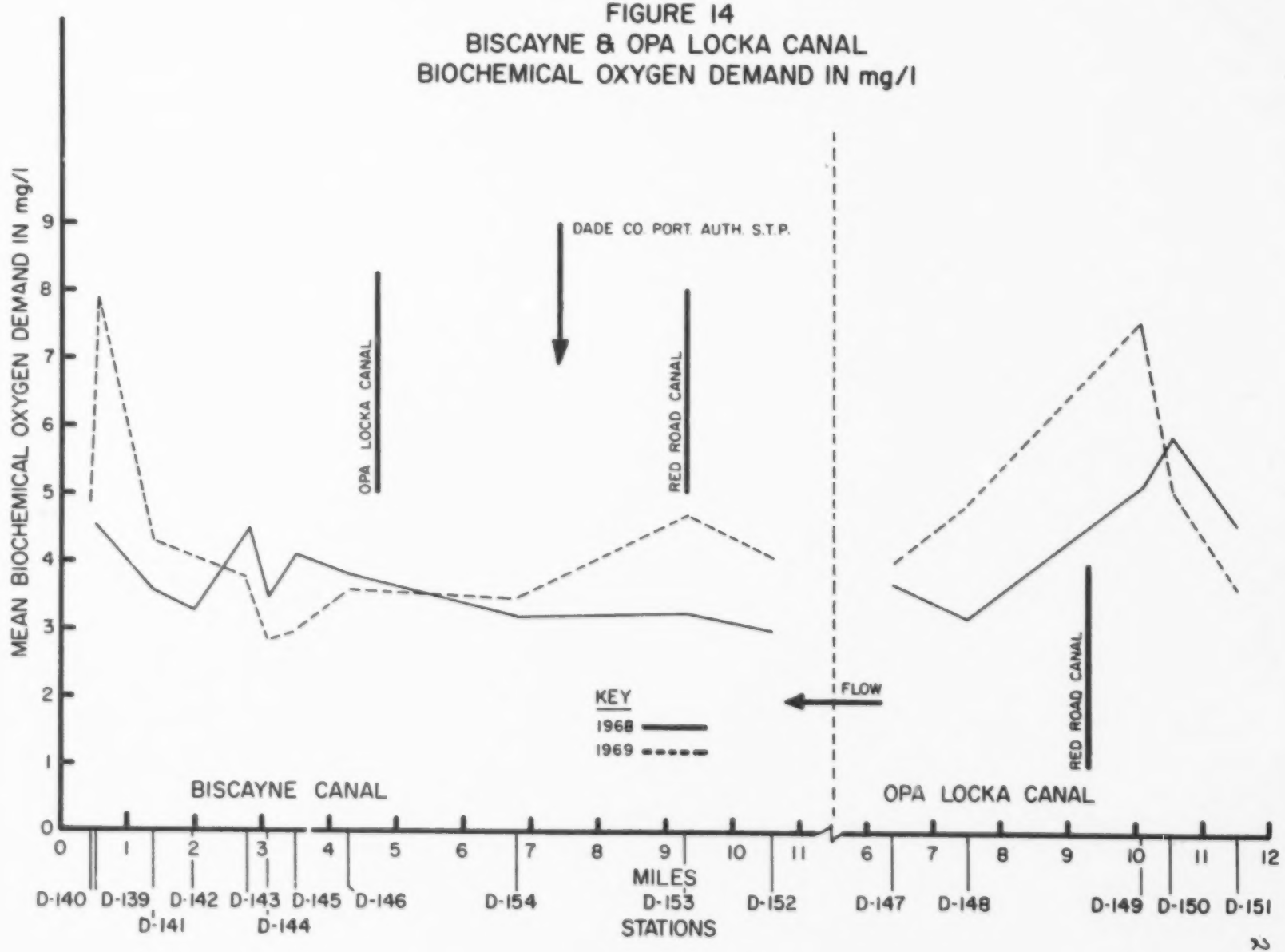


FIGURE 14
BISCAYNE & OPA LOCKA CANAL
BIOCHEMICAL OXYGEN DEMAND IN mg/l



All mean total coliform bacteria densities in both canals violated the standard of 1000 MPN per 100 ml (Figure 15). In general, densities in 1968 were higher than in 1969.

Tamiami Canal

The Tamiami Canal parallels U.S. Highway 41 from the west coast of Florida into Miami where it ultimately discharges into the Miami River. The only documented waste sources entering the canal from mile 12 to the mouth are two sewage treatment plants at the Miami International Airport, which discharge 0.436 and 0.346 mgd respectively.

The mean dissolved oxygen concentrations in the Tamiami Canal at all stations were greater in 1968 than in 1969. The lowest mean D.O. concentrations, ranging from 1.6 mg/l to 0.9 mg/l, occurred between mile 6 and 12. Higher mean concentrations were measured from mile 6 to the mouth, with the greatest mean being 3.7 mg/l, in 1968, at Station D120, mile 2.9. The D.O. profile of the Tamiami Canal violates the 4.0 mg/l standard (Figure 16).

As shown in Figure 17, the mean BOD concentrations in the canal indicate the waters are polluted. Again, the mean BOD values in 1968 were greater than in 1969. The highest mean concentration found was 4.4 mg/l in 1969 at Station D119 just downstream of the two waste discharges.

FIGURE 15
BISCAYNE & OPA LOCKA CANAL
TOTAL COLIFORM M.P.N. PER. 100 ml.

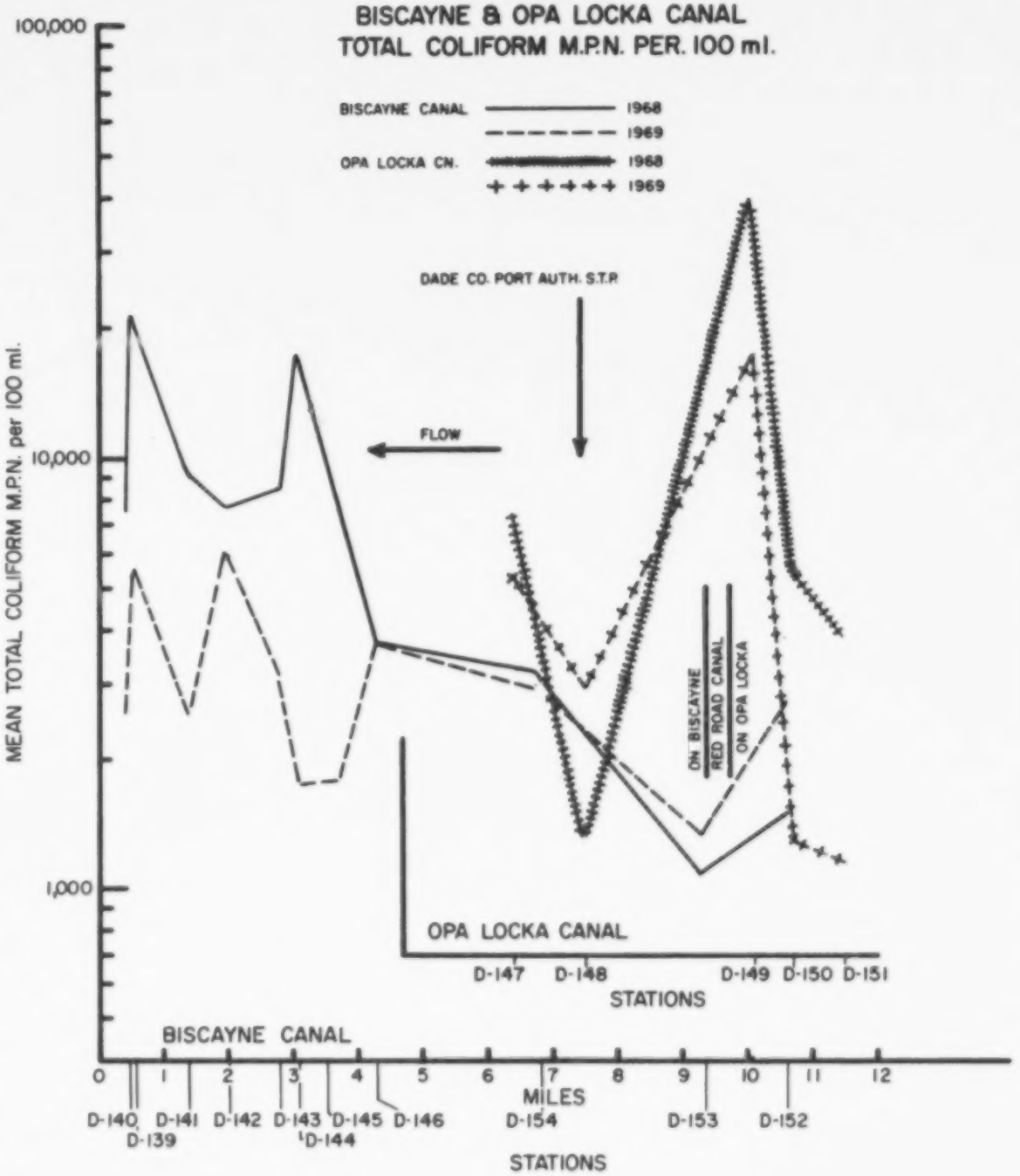


FIGURE 16
TAMIAMI CANAL
DISSOLVED OXYGEN IN mg/l

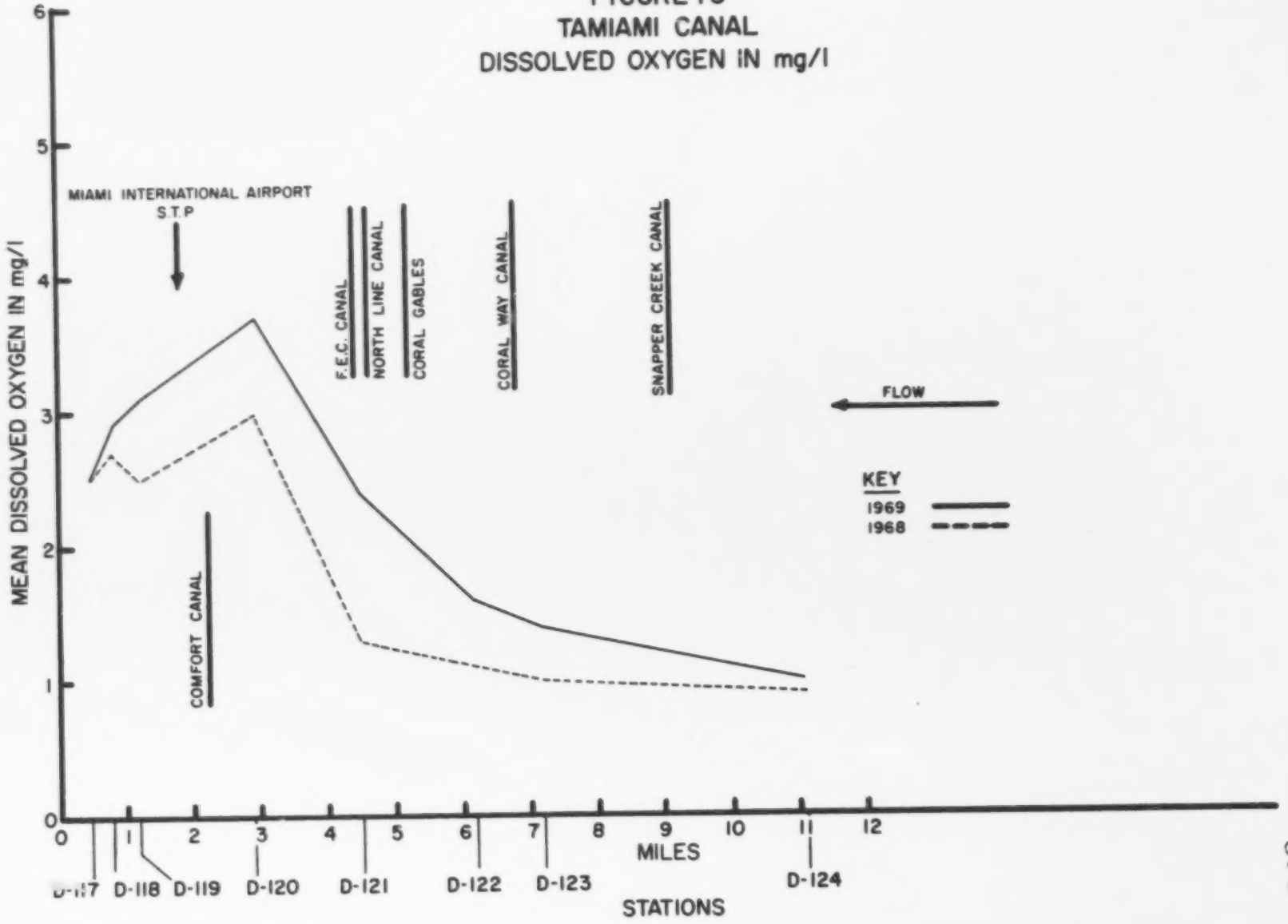
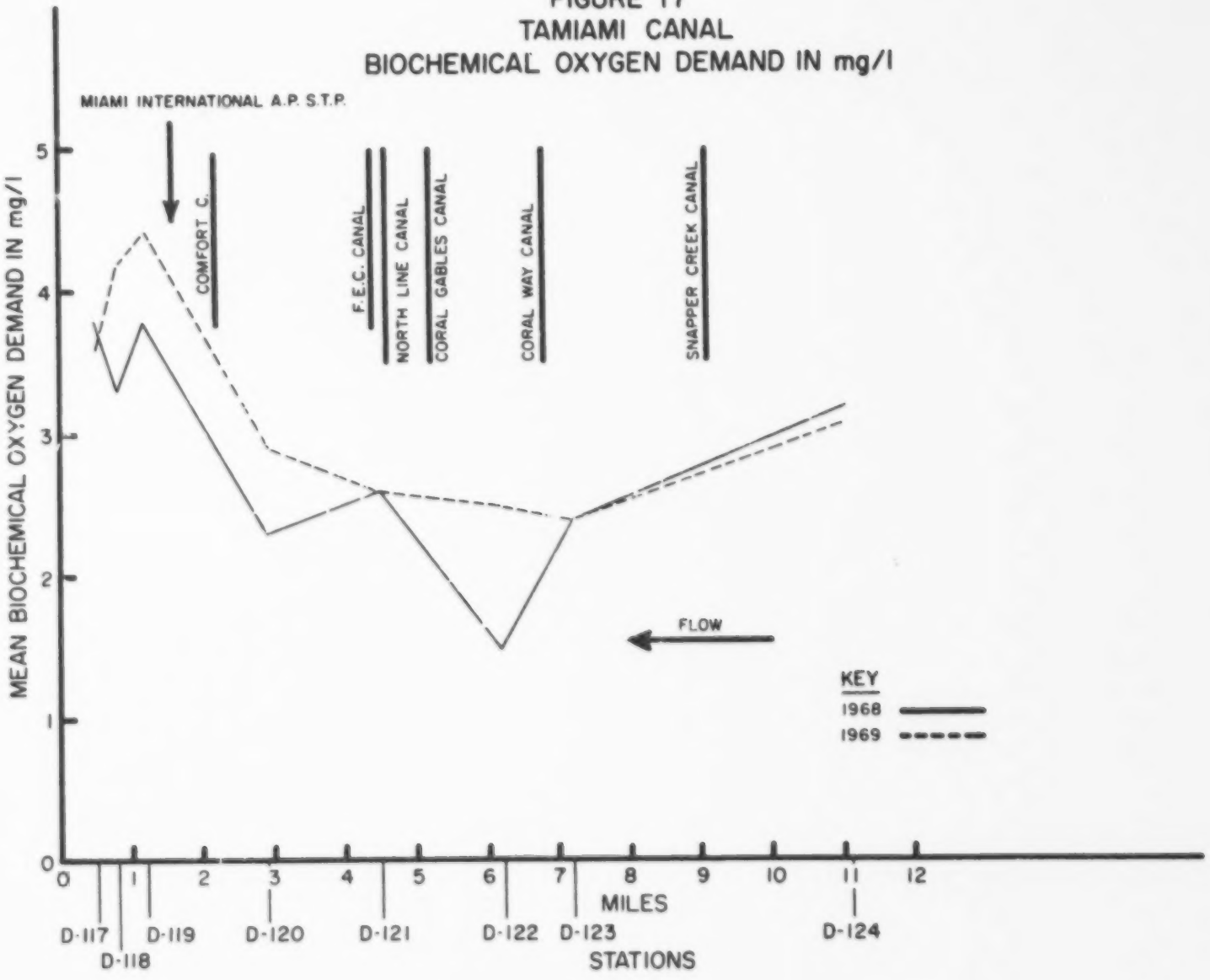


FIGURE 17
TAMIAMI CANAL
BIOCHEMICAL OXYGEN DEMAND IN mg/l

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The total coliform bacteria densities were lower in 1969 than in 1968.(Figure 18). In 1969, the mean total coliform density at four of the eight stations sampled violated the 1000 MPN per 100 ml standard. The highest mean density in 1969 occurred downstream of the sewage treatment plants near the mouth of the canal and was 31,000 MPN/100 ml.

Little River Canal

The Little River Canal is approximately 11 miles long and flows from the Miami Canal to Biscayne Bay where it discharges, through two channels, just south of the 79th Street Causeway. A spillway at mile 0.8 regulates flow and prevents saltwater intrusion.

Extremely low mean dissolved oxygen (D.O.) concentrations were observed in the canal as shown in Figure 19. The 1969 mean concentrations were all lower than the 1968 values and ranged from 1.8 mg/l, upstream of the dam, to 0.9 mg/l at mile 6.9. Mean D.O. concentrations throughout the canal violated the 4.0 mg/l standard.

The FWQA study found a mean D.O. concentration of 6.1 mg/l and a mean BOD concentration of 1.6 mg/l at Station 16 near the mouth of the northern discharge channel of the Little River Canal. In the southern discharge channel (Station 17) the mean D.O. was 6.0 mg/l and the mean BOD was 1.2 mg/l. At Station 40, mile 1.7, a mean D.O. of 3.1 mg/l and a mean BOD of 1.8 mg/l were observed (Figure 20).

From mile 6 to mile 11 most 1968 mean total coliform bacteria densities were greater in 1968 than in 1969. (Figure 21). However, from mile 6 to the mouth higher mean bacterial densities were observed in 1969. All mean bacterial densities in the Little River Canal violated the 1000 MPN per 100 ml water quality standard.

# FIGURE 18
## TAMIAMI CANAL
## TOTAL COLIFORM M.P.N. PER. 100 ml.

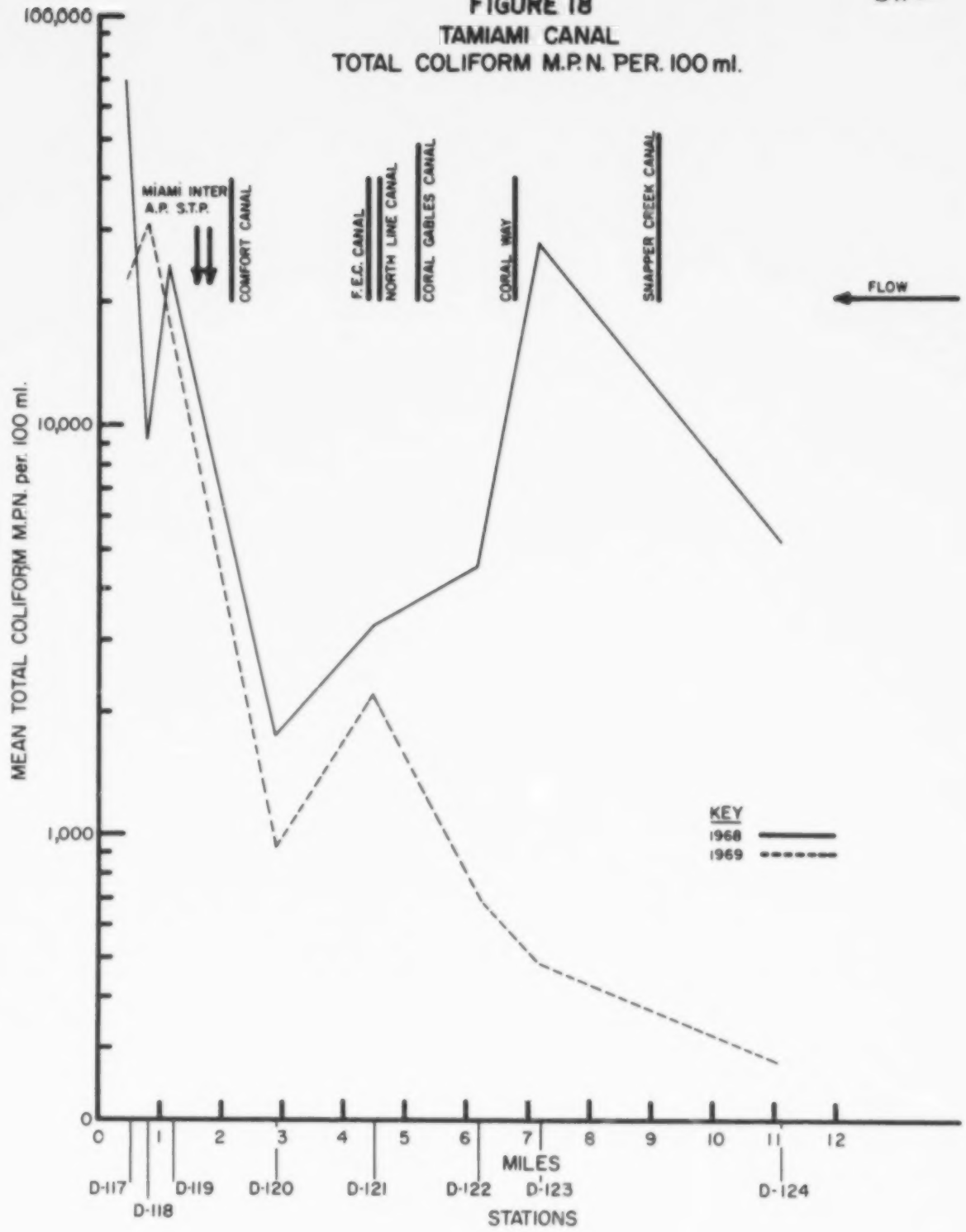


FIGURE 19
LITTLE RIVER CANAL
DISSOLVED OXYGEN IN mg/l

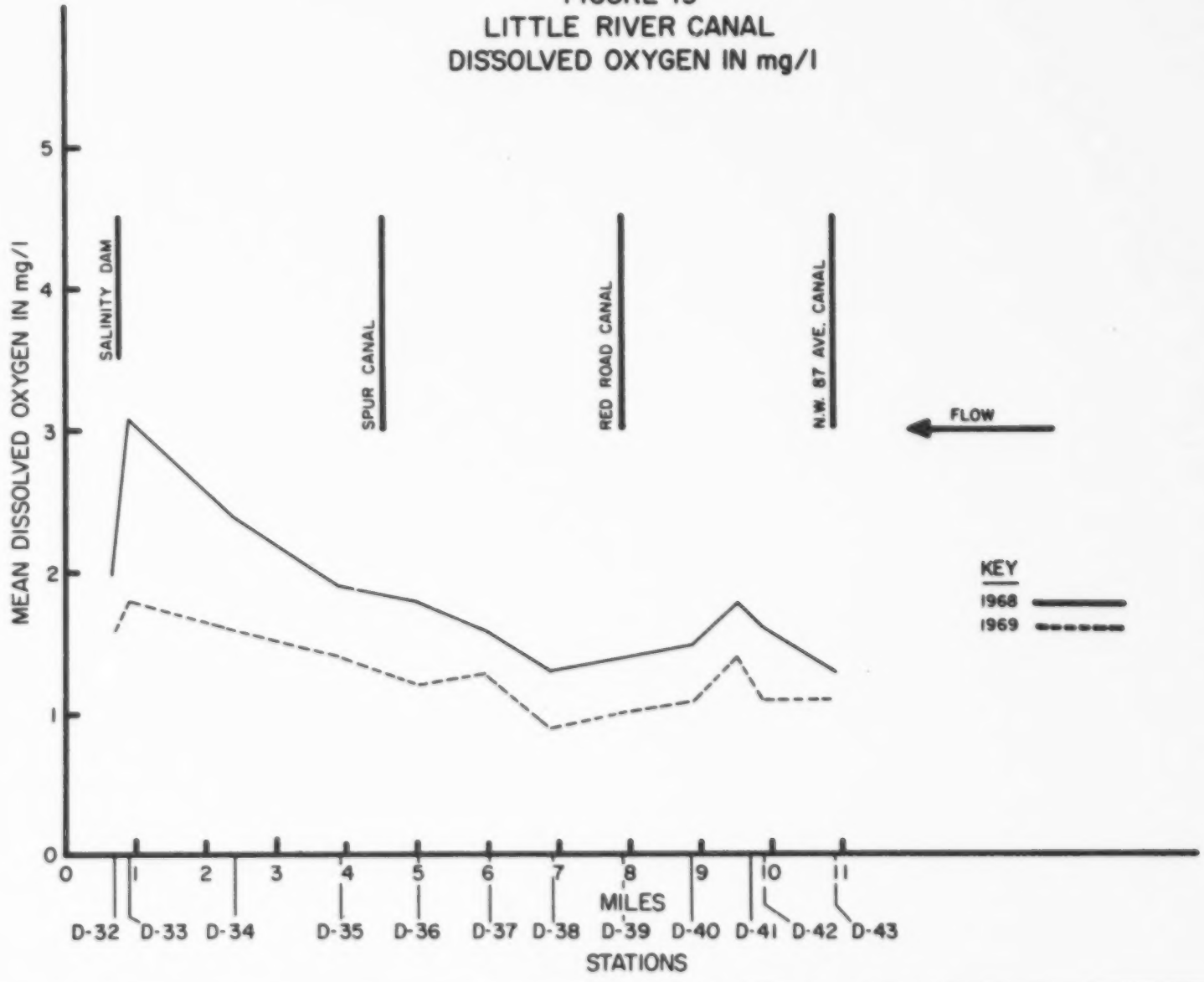


FIGURE 20

LITTLE RIVER CANAL

BIOCHEMICAL OXYGEN DEMAND IN mg/l

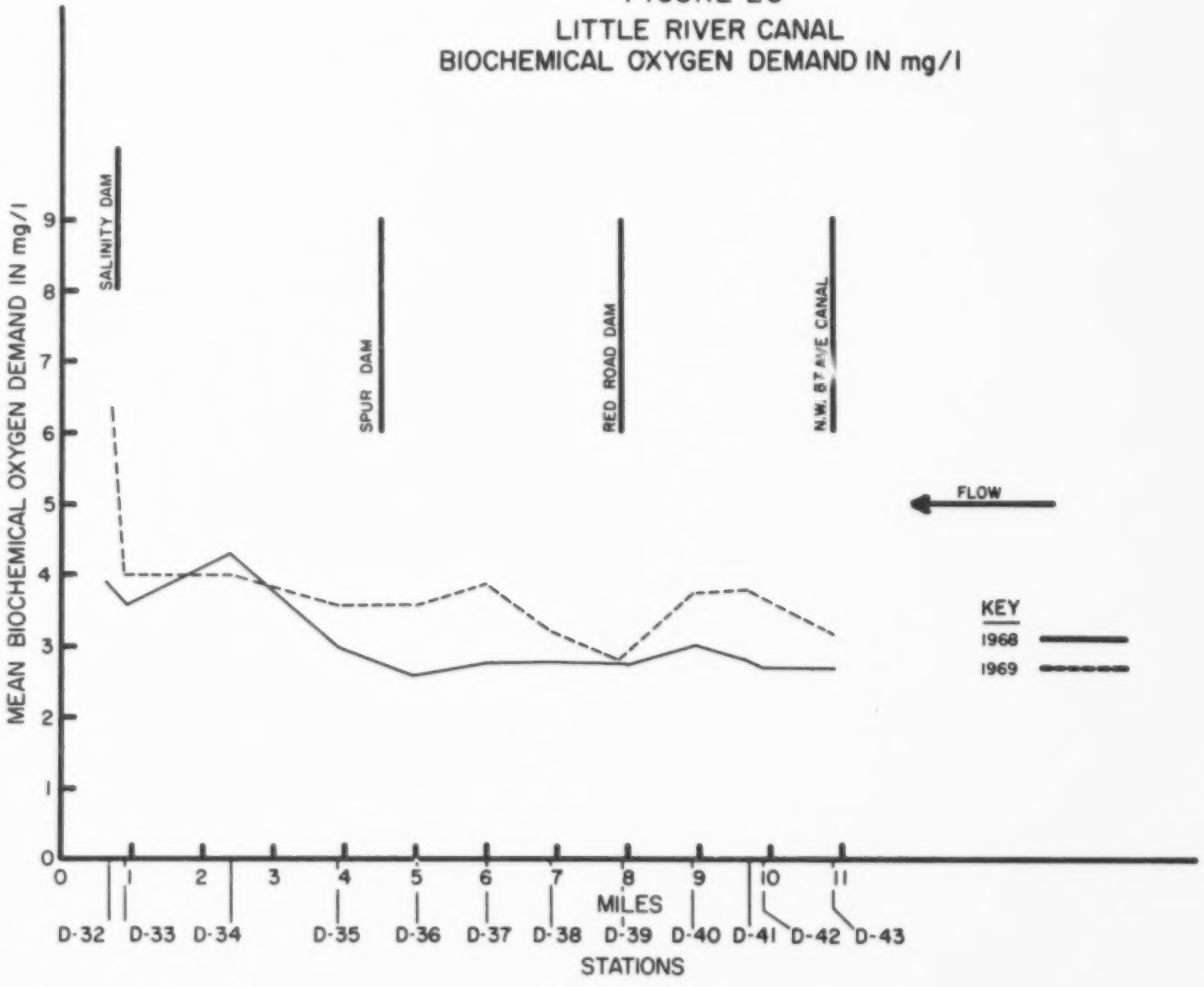
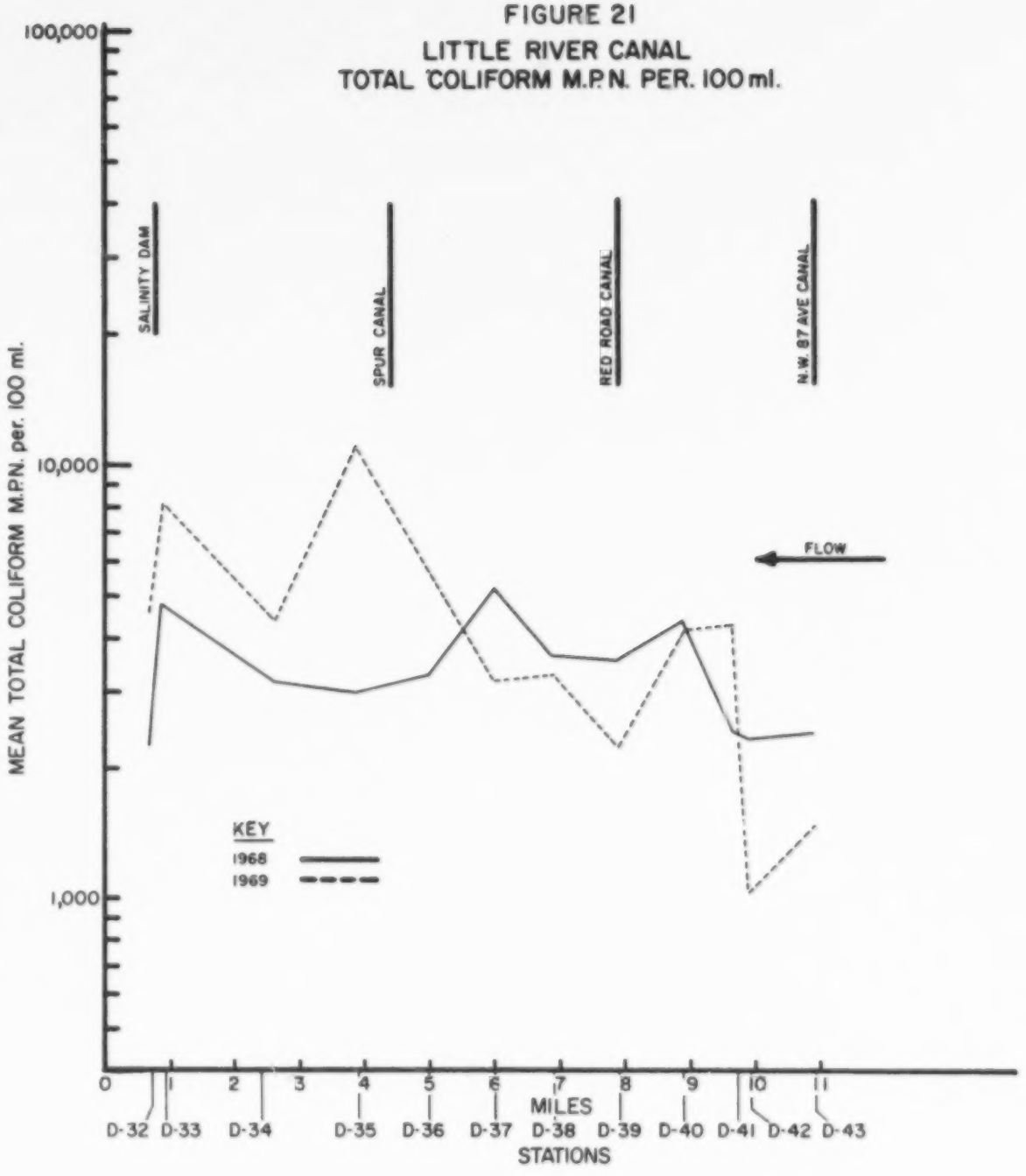


FIGURE 21
LITTLE RIVER CANAL
TOTAL COLIFORM M.P.N. PER. 100 ml.



Snake Creek Canal

Snake Creek Canal extends from Canal C-111 to the Oleta River. The reach from mile 12 to the mouth will be discussed in this section. A spillway is located near the mouth of the canal, and two sewage treatment plants discharge their effluents directly into the canal. The Andover Subdivision S.T.P. discharges 0.673 mgd of waste at mile 4.5 and the Riverdale Estates Subdivision S.T.P. discharges 0.49 mgd at mile 7.3. The Carol City Subdivision and the Myrtle Grove Subdivision sewage treatment plants discharge 2.2 and 2.13 mgd respectively into the Carol City Canal, which enters the Snake Creek Canal at mile 8.

The dissolved oxygen concentrations in the canal were lower in 1969 than in 1968. Mean D.O. concentrations upstream of mile 4 (Figure 22), ranged from 3.1 mg/l in 1968 at Station D160, mile 5.7, to 1.7 mg/l in 1969 at Station D164, mile 7.8. Downstream of mile 4 a high mean concentration of 5.1 mg/l in 1968 was observed at Station D158, mile 2.4, and a low mean of 2.3 mg/l in 1969 was found at this station. In 1968, seven of the eleven sampling stations had mean D.O. concentrations below the 4.0 mg/l standard. In 1969, the mean at one station equalled the standard and it was violated at all other stations.

The biochemical oxygen demand profile of Snake Creek Canal is shown in Figure 23. The 1969 mean concentration was generally greater than the 1968 concentration. The lowest mean values of 1.8 mg/l in 1969 and 2.1 mg/l in 1968 were found at Station D166, mile 8.8. The highest mean concentrations were 6.1 mg/l in 1969 at Station D155, mile 0.1, and 5.7 mg/l in 1968 at Station D157, mile 1.4.

FIGURE 22
SNAKE CREEK
DISSOLVED OXYGEN IN mg/l

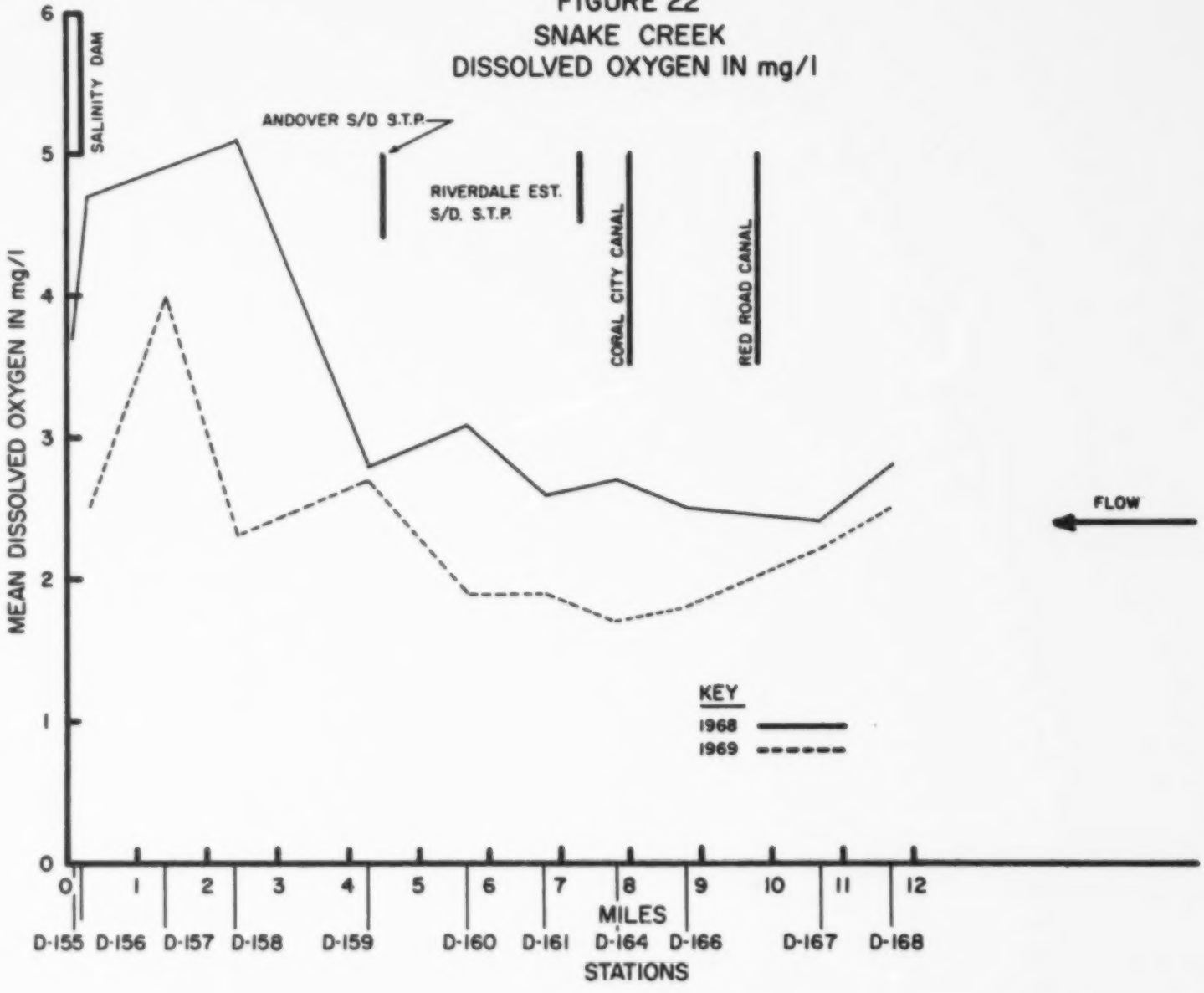
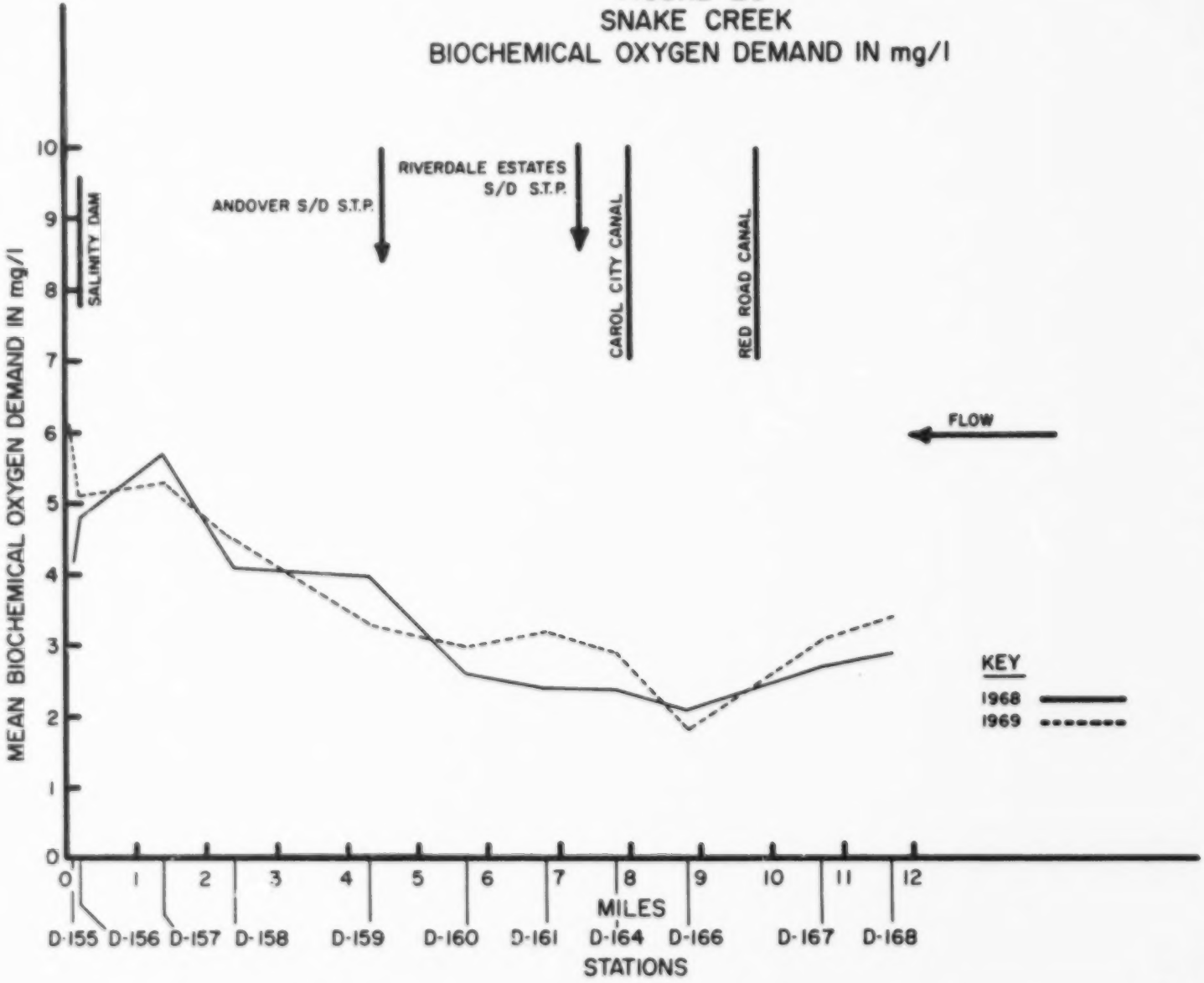


FIGURE 23
SNAKE CREEK
BIOCHEMICAL OXYGEN DEMAND IN mg/l



A mean D.O. of 5.7 mg/l and a mean BOD of 2.1 mg/l were found at Station 21 at the mouth of the Snake Creek Canal during the FWQA study. At Station 43, mile 0.6, a mean D.O. of 6.6 mg/l and BOD of 3.4 mg/l were observed.

Total coliform bacteria densities were greater in 1968 than in 1969 (Figure 24). In 1968, nine of the eleven sampling stations violated the 1000 MPN per 100 ml standard and in 1969, eight stations were in excess of the standard.

Oleta River

The 2.7 mile reach of the Oleta River from the Broward County line to U.S. Highway 1 will be discussed in this section. The Golden Isle Subdivision S.T.P. discharges 0.485 mgd in this reach.

The mean dissolved oxygen concentrations at all stations were lower in 1969 than in 1968, and the biochemical oxygen demand and total coliform concentrations were generally higher in 1969 than in 1968. The effect of the sewage discharge is in evidence downstream of the sewage treatment plant. The D.O. concentration drops and the BOD and total coliform concentrations rise (Figures 25, 26, and 27).

During the FWQA study, the mean D.O. concentration was 4.7 mg/l and the mean BOD concentration was 1.7 mg/l at Station 44, mile 0.7.

# FIGURE 24
## SNAKE CREEK
## TOTAL COLIFORM M.P.N. PER. 100 ml.

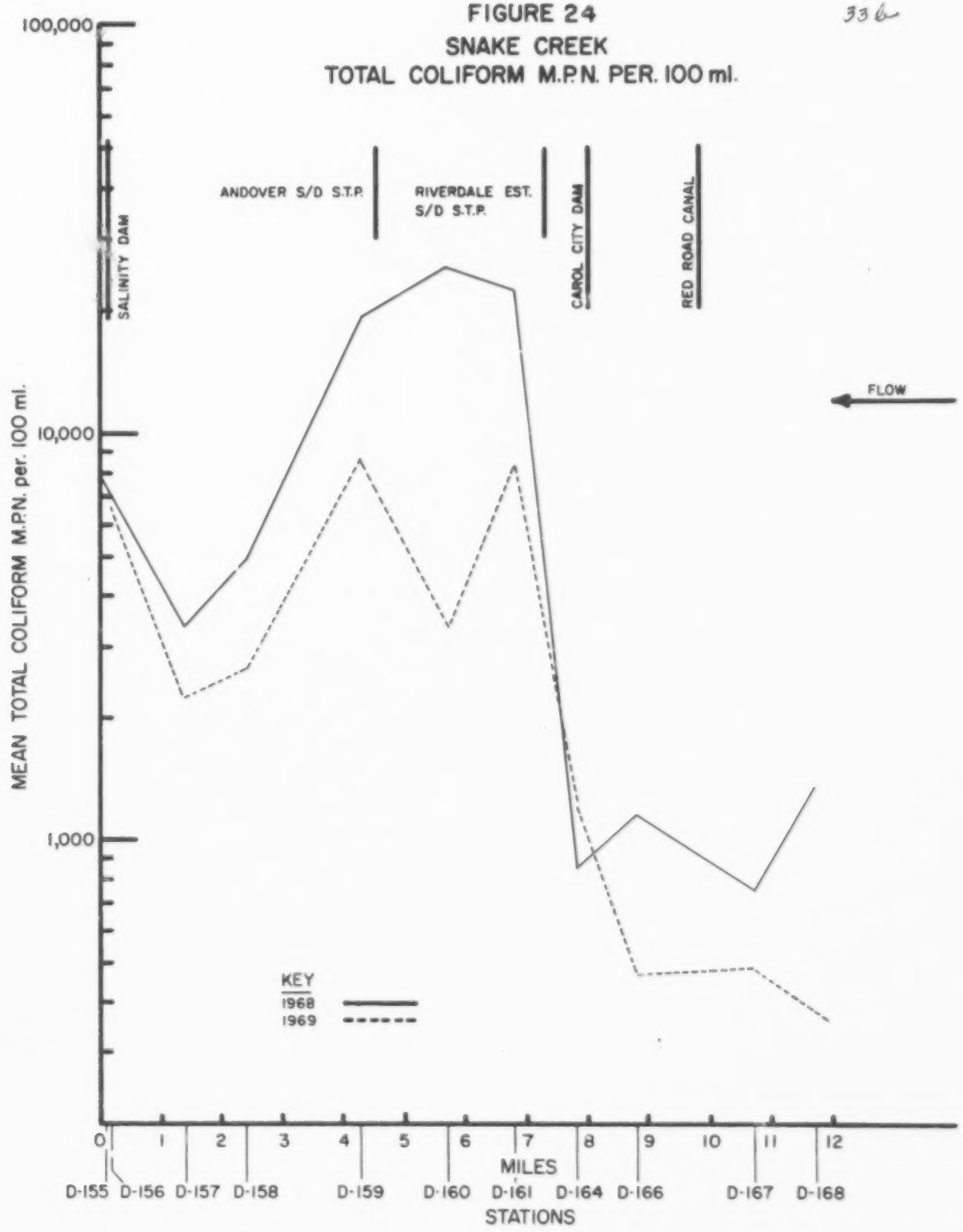


FIGURE 25
OLETA RIVER
DISSOLVED OXYGEN IN mg/l

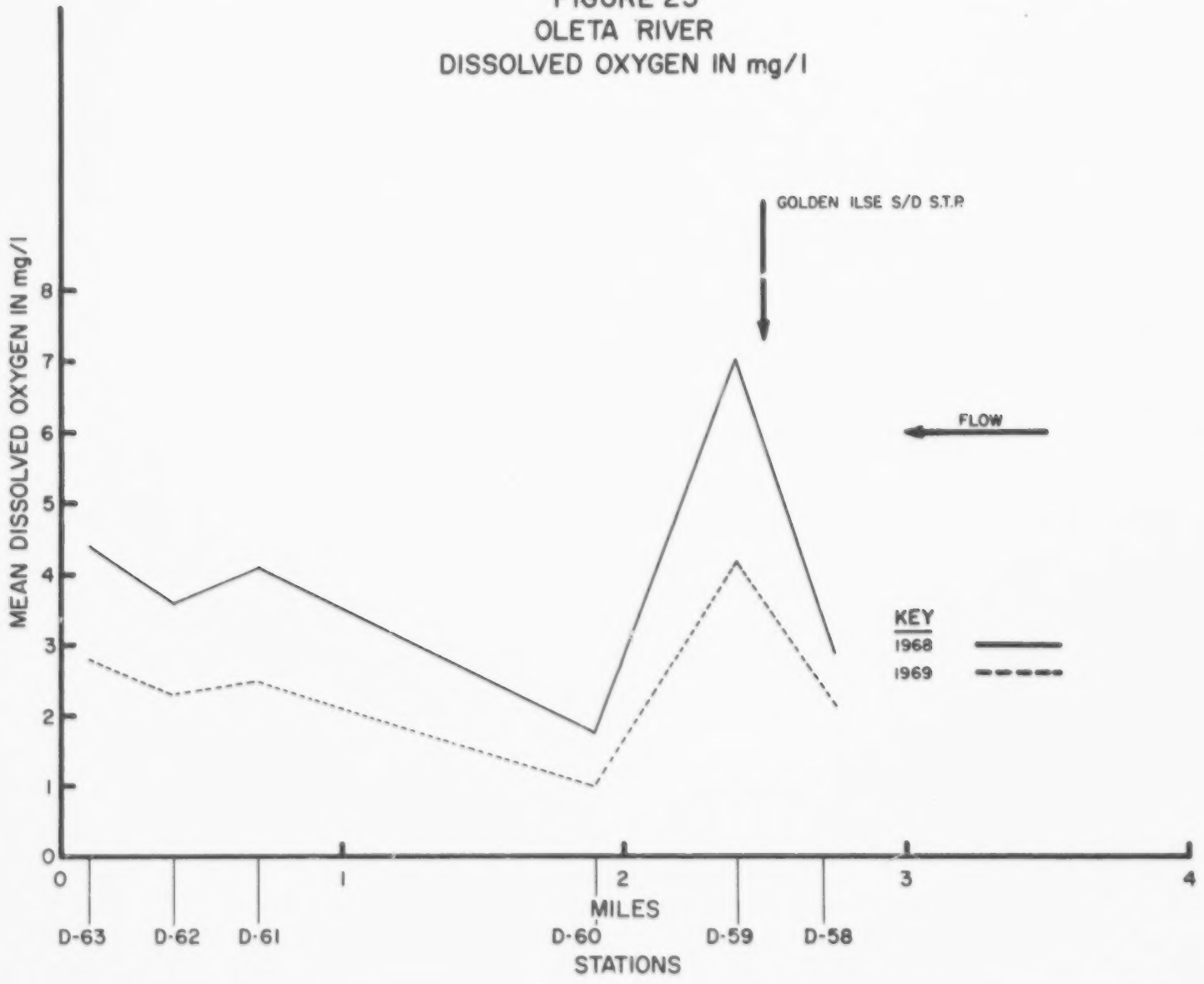


FIGURE 26
OLETA RIVER
BIOCHEMICAL OXYGEN DEMAND IN mg/l

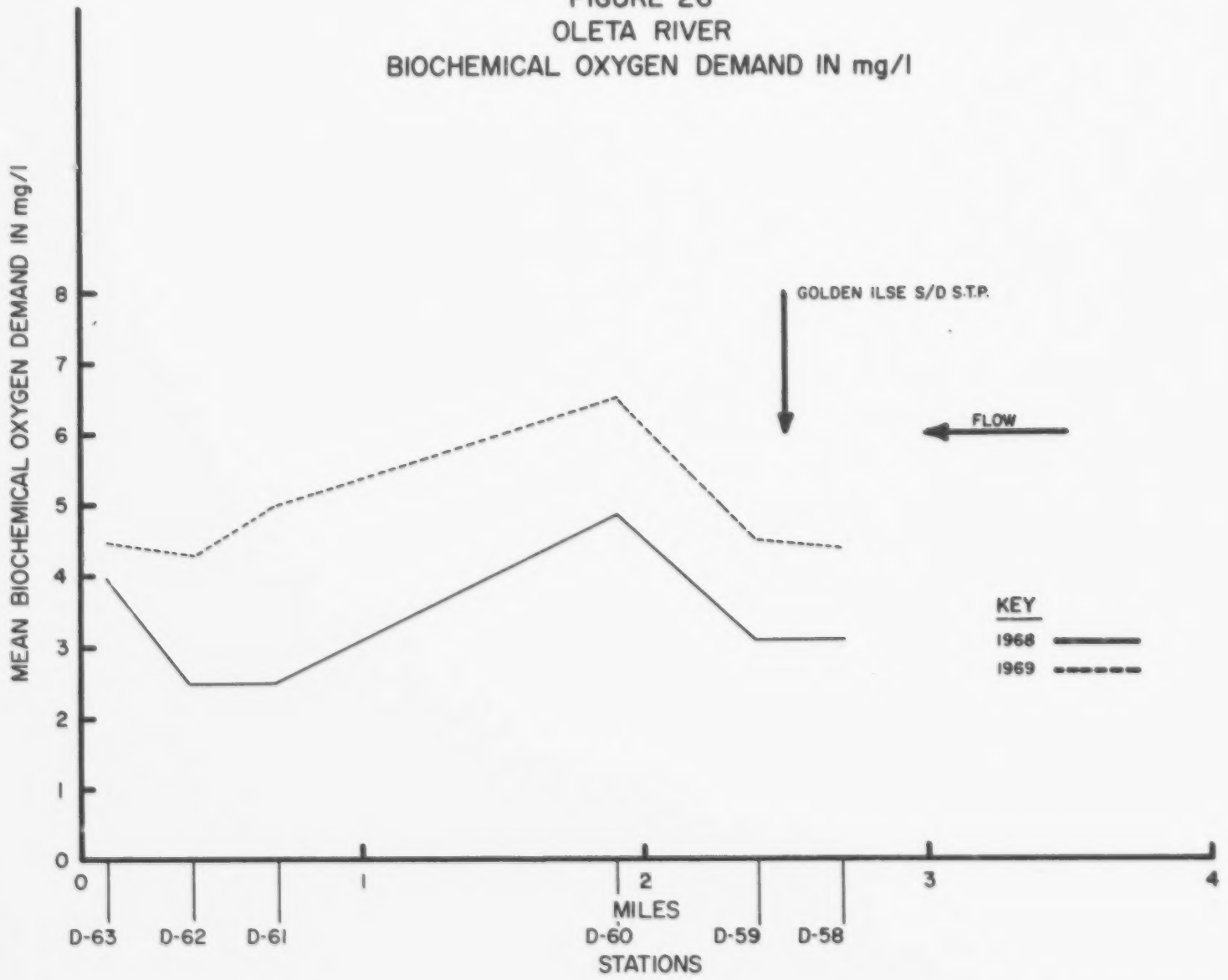
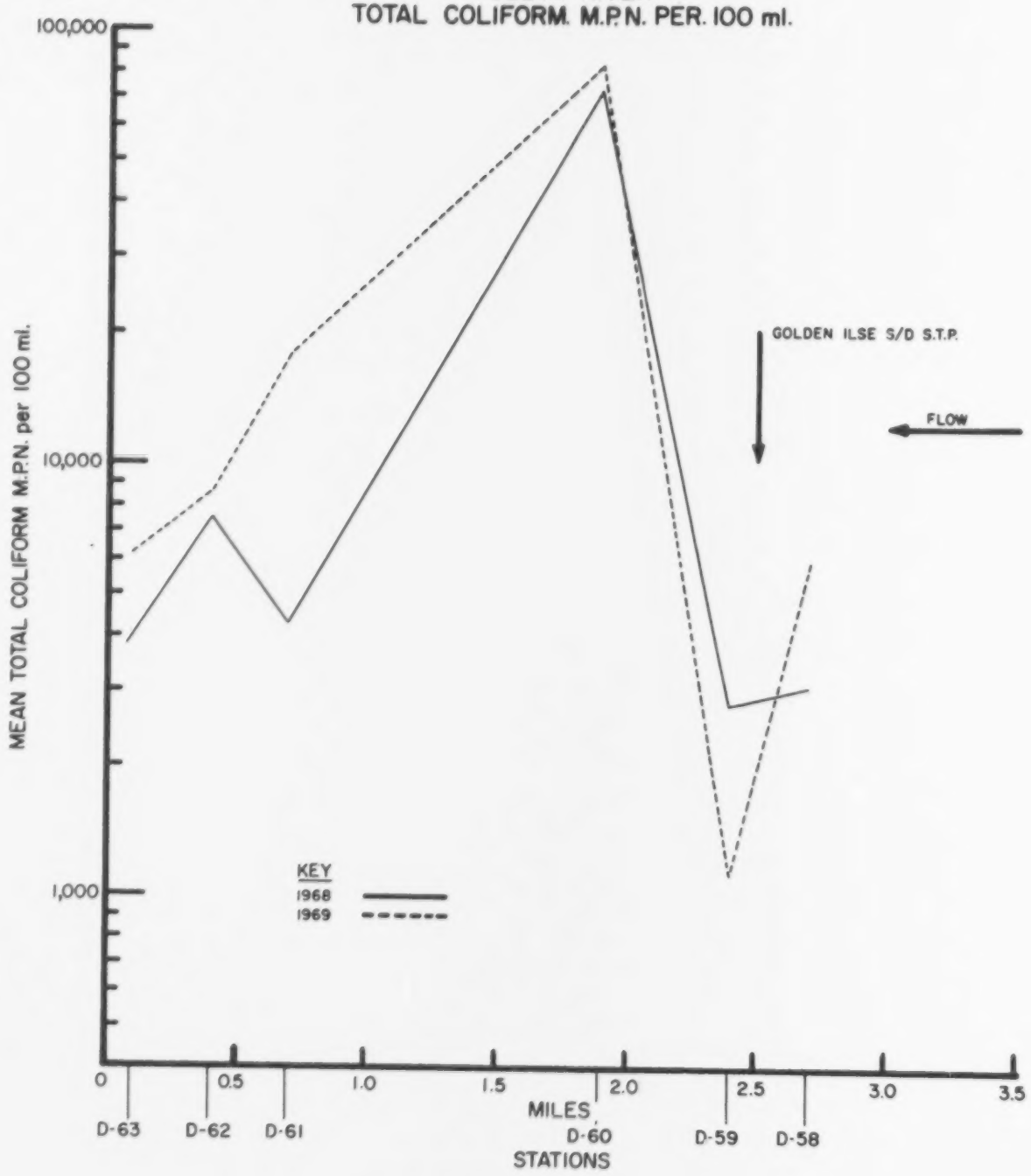


FIGURE 27
OLETA RIVER
TOTAL COLIFORM M.P.N. PER 100 ml.



SOUTHERN DADE COUNTY CANALS

The major canals in Southern Dade County are in the Lower Biscayne Bay drainage and include C-100, Black Creek, C-102, C-103 (Mowry Canal), Military Canal, and Florida City Canal. Water quality in these canals is relatively better than in the north Dade County canals. Drainage basins are less densely populated and, in the extreme southern end of the county, land use is principally agricultural.

Black Creek receives treated sewage effluent from two private utility company plants, South Miami Heights and South Coral Homes. A new plant serving the Goulds-Perrine area will also discharge into Black Creek near Hamlin Mill Drive. Black Creek discharges directly into the Biscayne National Monument near its northern boundary. Dissolved oxygen at Station D-66, Old Cutler Road, averaged 4.3 mg/l in 1968 and 2.5 mg/l in 1969. BOD increased from 3.3 mg/l in 1968 to 4.7 mg/l in 1969. Coliform bacteria densities averaged 32,950 MPN/100 ml and 56,141 MPN/100 ml in 1968 and 1969 respectively. These coliform concentrations are in violation of the established standard as are the 1969 D.O. concentrations.

FWQA data from 10 samples at Station D-66 indicate very high nutrient levels: 1.12 mg/l phosphate as P, 2.19 mg/l total Kjeldahl Nitrogen as N, 1.40 mg/l of Ammonia as N, and 0.26 mg/l of Nitrate as N. These levels of nutrients, particularly ammonia and nitrate, are indicative of a highly putrescible organic waste such as sewage.

Below the salinity barrier at levee L-31E in the tidal portion of Black Creek Canal the D.O. averaged 4.3 mg/l in 1968 and 3.1 mg/l in 1969.

Coliform bacteria concentrations were also higher in 1969 than 1968 with values of 23,111 MPN/100 ml and 5583 MPN/100 ml respectively.

Goulds Canal is a short straight ditch along Coconut Palm Drive from about 120th Avenue to the Bay. It has no known direct sewage discharges. However, D.O. at Station D-44 shows a substantial decrease from 5.4 mg/l in 1968 to 2.6 mg/l in 1969. FWQA data indicate an unusually high nitrate concentration of 3.28 mg/l while all other nutrients, including phosphate and ammonia are very low. This is indicative of a highly nitrified discharge reaching the waterway perhaps through subsurface seepage.

FWQA data from 9 samples on C-102 (Moody Canal) show high nitrates (1.56 mg/l as N) with acceptable levels of all other constituents, again indicating possible subsurface seepage.

Military Canal has been subject to several fish kills in recent years. Improperly treated sewage effluent from Homestead Air Force Base, with at least one instance of raw sewage bypassed directly to the canal, has been blamed for these kills. At Station D-46 (S. W. 107th Avenue), D.O. averaged 5.1 mg/l in 1968 and 1.8 mg/l in 1969. Occasions of zero D.O. were observed. Twelve samples by FWQA shows an average BOD of 15.1 mg/l, 2.5 mg/l total phosphate as P, 4.18 mg/l total kjeldahl nitrogen as N and 2.91 mg/l Ammonia as N. All of these concentrations are indicative of severely polluted conditions and the 1969 D.O. concentrations are in violation of Federal, State and local standards. Concentrations at the mouth of the Canal, after dilution in the tidal water of Biscayne Bay

were: 4.2 mg/l of BOD, 0.4 mg/l of total phosphate as P and 0.41 mg/l of Ammonia as N. Military Canal discharges directly into the Biscayne National Monument.

Mowry Canal (C-103) is well covered by the Dade County monitoring program although many of the stations have only one year (1969) of data available at this time. Dissolved oxygen levels are quite low, ranging from 2.0 mg/l to 4.3 mg/l. BOD levels are correspondingly high, ranging up to 20 mg/l. North Canal, which connects to Mowry Canal to form a combined discharge, receives sewage effluent from the City of Homestead plant. Dade County's data show D.O. averages about 3.0 mg/l and BOD averages above 4.0 mg/l in that reach of the canal. Coliform bacteria densities averaged 6,123 MPN/100 ml at Station D-51 in 1969, down markedly from the average of 1,336,000 MPN/100 ml reported for 1968. The combined flow of Mowry and North Canal flows into the Biscayne National Monument some two miles north of Turkey Point. Both D.O. and coliform levels are in violations of Federal, State and local standards.

Finally, Florida City Canal originates at U.S. Highway 1 and flows eastward to Biscayne Bay. Four sampling stations on this canal indicate that D.O. averaged less than 2.6 mg/l in 1969 and that it was lower in 1969 than in 1968. There are no known sewage effluents discharging into Florida City Canal.

UPPER AND MIDDLE BISCAYNE BAY

There is very little water quality data available for upper Biscayne Bay and no data available for the middle bay. Water quality data from the

upper bay were collected by FWQA during February through May 1969. One to ten samples were collected at each station.

At Station 12, near the Venetian Causeway, the mean D.O. concentration was 8.4 mg/l and the mean BOD was 1.9 mg/l. In Government Cut the mean D.O. was 7.1 mg/l and the mean BOD was 1.3 mg/l near the inlet. Near the Miami end of the cut, the D.O. averaged 7.6 mg/l and the average BOD was 2.0 mg/l. At the Rickenbacker Causeway an average D.O. of 7.4 mg/l and a mean BOD of 2.0 mg/l were observed. Between Virginia Key and Key Biscayne the mean D.O. was 7.4 mg/l and the mean BOD was 1.7 mg/l.

Water quality data in the Intracoastal Waterway north of Biscayne Bay were also collected by FWQA. A mean D.O. of 7.1 mg/l and a mean BOD of 2.2 mg/l were observed at Station 22 which is in the Intracoastal Waterway just south of the Sunny Isle complex. At Station 20 in the Intracoastal Waterway at Golden Beach the mean D.O. was 5.9 mg/l and the mean BOD was 1.4 mg/l.

The quantity and scope of the data presently available for upper Biscayne Bay will not allow any conclusions regarding water quality.

LOWER BISCAYNE BAY

Lower Biscayne Bay has been the object of extensive study by FWQA and other agencies for the past several years. Data from all known sources indicate that with respect to the chemical and bacteriological parameters normally associated with sewage or organic pollution the open water of lower Biscayne Bay is of extremely high quality.[12][13]

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(12) "Report on Thermal Pollution of Intrastate Waters Biscayne Bay, Florida, FWQA, February 1970.

(13) Roessler, M. A., Tabb, D. C. and Bader, R. G., "An Ecological Study of South Biscayne Bay in the Vicinity of Turkey Point", January 1970.

The significant pollution problem of the lower Bay is that of thermal discharges which were considered at an enforcement conference in February of 1970.

ATLANTIC OCEAN

The only water quality data available for the Atlantic Ocean were collected by the Dade County Health Department as part of its routine bacterial surveillance program of Miami Beach, and by the Dade County Pollution Control Department during a study of the Miami Beach ocean outfall.

Raw sewage is discharged into the Atlantic Ocean at two locations in Dade County. Seventeen million gallons per day (mgd) of raw waste from Miami Beach are discharged at 74th Street through a 36-inch outfall which extends 6,000 feet into the Atlantic Ocean. A second outfall at 163rd Street discharges about 11 mgd through a 48-inch pipe which extends 11,000 feet into the ocean. Secondary effluent from the City of Miami Sewage Treatment Plant at Virginia Key is also discharged to the ocean through an outfall. This outfall is 70 inches in diameter and extends 4,600 feet in the ocean. The quantity of waste discharged is 47 mgd.(14)

Samples for total coliform analysis were collected from the surf on a monthly basis at 20 sampling stations from Miami Beach Pier in the south to Golden Beach in the north. The highest median total coliform bacteria density observed in 1968 was 48 MPN/100 ml at 96th Street. The median densities in 1969 were all lower than those for 1968, with a high median value of 8.5 MPN/100 ml occurring at Haulover Pier. In 1969, the months of January and February had higher bacterial densities than the other months.

(14) Letter dated July 23, 1970, Paul Leach to Vincent Patton.

The maximum density in January was 920 MPN per 100 ml at 31st Street. No densities quite as high were observed in February and the median density for the entire surveillance area was 79 MPN per 100 ml during both months. During 1968, the highest coliform bacteria densities were observed in August. Values of 1600 MPN per 100 ml were found at 88th Street, Haulover Pier, and Golden Beach. In February of that year a total coliform density of 2300 MPN per 100 ml was observed at Miami Beach Pier.

On July 28, 1968, a special study of the effluent point of the Miami Beach ocean outfall was performed by Dade County Pollution Control.(15) Total coliform bacteria densities at the four boils, 6,900 feet from the shore, ranged from 5,400,000 to 54,000 MPN per 100 ml at the surface. Four hundred and fifty feet north of the outfall line surface concentrations ranging from 3,500,000 to 330,000 MPN per 100 ml were observed, and at the same distance south of the outfall the range of concentrations was 1,700,000 to 79,000 MPN. Bottom samples collected during the study were significantly lower, ranging from 4900 to 130 MPN per 100 ml. Additional data, collected on July 13, 1970, indicated the fecal coliform bacteria densities at the 74th Street pumping station were 16,000,000 MPN per 100 ml.

Dissolved oxygen concentration in the vicinity of the effluent plume varied from 4.0 to 6.4 mg/l and no difference between surface and bottom concentrations was observed. The biochemical oxygen demand values

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(15) Metropolitan Dade County Pollution Control, Special Water Pollution Control Survey, Effluent Point of Miami Beach Outfall, July 28, 1970.

varied from 5.8 to 1.2 mg/l at the surface, 2.4 to 0.8 mg/l at the bottom, and 4.0 to 1.2 mg/l at 10 feet below the surface.

There is generally paucity of data for the Atlantic Ocean off the coast of Lower Florida. No information was available with regard to water quality in the vicinity of the North Miami and Virginia Key outfalls. Additional information pertaining to the effects of outfalls on the water quality and the biota of the open ocean receiving waters is needed.

## SUMMARY AND DISCUSSION

Water quality data presented herein for the Coral Gables Waterway, Miami River, Snapper Creek Canal, Biscayne and Opa Locka Canals, Tamiami Canal, Little River Canal, and Snake Creek Canal, indicate that the inland waters of northern Dade County are grossly polluted.

Dissolved oxygen concentrations of less that 4.0 mg/l were found in all canals most of the time during 1968 and 1969.

Biochemical oxygen demand generally varied inversely as D.O. indicating that the decreased D.O. is due to the decay of organic material rather than any naturally occurring phenomenon.

Coliform bacteria densities exceeded the 1000 MPN per 100 ml standard in every canal during 1968 and 1969. These bacteria are indicative of sewage discharges.

Decreased D.O. and increased BOD concentrations and coliform bacteria densities correspond to known sources of municipal waste and further implicate these sources as the principal cause of deteriorated water quality.

The canals of southern Dade County which discharge into the Biscayne National Monument exhibit some water quality degradation from sewage effluent although they are not as grossly polluted as the canals in the northern population center of the county. Several instances have been noted in Black Creek and Military Canal in which water quality criteria are being violated. Also noted in most of the waters are high levels of nutrients, especially ammonia and nitrates and coliforms which may be indicative of subsurface seepage of septic tanks and agricultural runoff.

Insufficient data are available to draw conclusions regarding water quality in Upper and Middle Biscayne Bay. Data reported elsewhere show Lower Biscayne Bay to be almost completely free of sewage or organic pollution based on its extremely high chemical and bacteriological water quality.

Very limited data on the open waters of the Atlantic Ocean show bacteriologically degraded conditions in the immediate vicinity of the municipal ocean outfalls. Coliform levels reported at inshore areas were generally below the established standard of 1000 mpn/100 ml with several exceptions.

The ground, surface, estuarine and ocean waters in Dade County are interrelated. The canals recharge groundwater and receive water from the ground during dry periods, and they also discharge into Biscayne Bay while water from the Bay is exchanged with ocean water and vice versa. Therefore, if the water quality of the canals is allowed to deteriorate further, especially in the northern portion of the County, or even remain the same, serious problems will occur throughout the water system. One potential problem is pollution of the groundwater, which is the water supply for Dade County. The Hialeah-Miami Springs well field is located within 3000 feet of the acutely polluted Miami Canal and the southwest Dade well field is within a mile of the Snapper Creek Canal. Groundwater levels in the well field areas are highly dependent upon recharge from these canals. Eventually ground water in this area may become so polluted that it cannot be used as a safe water supply even after conventional treatment.

Another problem could occur if water from the canals is backpumped into the conservation areas. Such a proposal is being considered by the U.S. Army Corps of Engineers and the Central and Southern Florida Flood Control District. At present, there is no information readily available regarding the condition of the regions that could receive the backpumped canal water. This information, together with the operation plan for the flow regulating devices on the canals, must be known and made available before their effects on water quality can be determined.

The establishment of the Biscayne National Monument in Lower Biscayne Bay will require the continued preservation of the existing high quality of its waters. Present and especially future waste discharges to the Lower Bay and its tributaries must be strictly controlled. To this end, consideration should be given to complete removal of all waste effluents from this area.

The question of ocean outfalls has not been adequately investigated to allow for definite conclusions on their effects. The long-term effects in both estuarine and open waters has not been adequately measured although available data indicate these effects may be minimal. However, little if any consideration has been given to the effect of discharging these large amounts of fresh water to the ocean on the continued availability of fresh water in Dade County. With the projected population growth of the area to 2.7 million people, consideration must be given to not only protecting the water quality but also reclaiming this water to assure a continued adequate supply.

Finally, a regional water quality management plan for the entire south Florida population corridor is needed. Such a plan would include considerations of advanced waste treatment, groundwater recharge, ocean outfalls, reclamation of water for recycling to the water conservation areas, control of discharge of fresh water to the ocean, and the effects of future developments in up-state areas on the water quality and supply in Southeast Florida.

# APPENDICES

APPENDIX A-1

SAMPLING STATIONS

Dade County

Dade County Pollution Control Authority

| STATION | CANAL | LOCATION |
|---|---|---|
| D1 | C-100C | N. Kendall Drive |
| D2 | | Killian Dr. and SW 112th St. |
| D3 | | US #1 |
| D4 | | Casa Granada - Downstream |
| D5 | C-100A | US #1 |
| D6 | | Chapman Field Dr. - SW 124th St. |
| D7 | | Coral Reef Dr. - SW 152nd St. |
| D8 | | Richmond Dr. - SW 168th St. |
| D9 | C-100 | Richmond Dr. |
| D10 | | US #1 |
| D11 | | SW 117th Ave. |
| D12 | C-100B (Bel-Aire | Eureka Dr. |
| D13 | Canal) | SW 97th Ave. |
| D14 | | Marlin Dr. |
| D15 | C-103 | E. side Salinity Dam |
| D16 | | W. side Salinity Dam |
| D17 | | Allapattah and SW 318th St. |
| D18 | | 6-Mile Rd. - SW 117th Ave. and 318th St. |
| D19 | | Downstream - NE 5th St. |
| D20 | | Upstream - NE 5th St. |
| D21 | Red Road Canal | NW 57th Ave. and 202nd St. |
| D22 | | NW 167th St. |
| D23 | | NW 142nd St. |
| D24 | | W 68th St. |
| D25 | | W 56th St. |
| D26 | | W 49th St. |
| D27 | | W 37th St. |
| D28 | | W 23rd St. |
| D29 | | W 16th St. |
| D30 | | W 16th Ct. and 68th St. |
| D31 | | W 17th Ave. and 68th St. |
| D32 | Little River Canal | NE 79th St. Bridge - S. of Dam |
| D33 | | NE 83rd Ct. - N of Dam |
| D34 | | NW 7th Ave. |
| D35 | | NW 17th Ave. and 103rd St. |
| D36 | | NW 27th Ave. and 106th St. |
| D37 | | E 11th Ave. and 52nd St. Hia.-Seaboard |
| D38 | | E 4th Ave. and 52nd St., Hia.-Famingo Way |
| D39 | | Red Road - W. 4th Ave., Hialeah |
| D40 | | W 12th Ave., Hialeah |
| D41 | | Burdines-Downstream |
| D42 | | Palmetto Bypass |
| D43 | | Everglades Fire Station |

APPENDIX A-1 (Continued)

SAMPLING STATIONS

| STATION | CANAL | LOCATION |
|---|---|---|
| D44 | Goulds Canal | Allapattah Rd. |
| D45 | | SW 97th Ave. |
| D46 | Military Canal | SW 107th Ave. |
| D47 | | Homestead AFB |
| D48 | North Canal | Flood Control Dam |
| D49 | | 6-Mile Rd. |
| D50 | | Tallahassee Rd., 137th Ave. |
| D51 | | SW 162nd Ave. |
| D52 | | Feeder Canal - South of 162nd Ave. |
| D53 | | City of Homestead STP Driveway |
| D54 | Florida City Canal | US #1 |
| D55 | | Stone Bridge |
| D56 | | Tallahassee Rd.-137th Ave. |
| D57 | | 6-Mile Road |
| D58 | Oleta River | NE 215th St. |
| D59 | | NE 209th Terr. |
| D60 | | NE 203rd St. |
| D61 | | Miami Gardens Drive |
| D62 | | Oleta Drive |
| D63 | | West Dixie Highway |
| D64 | Black Creek | Salinity Dam-East-SW 87th Ave. |
| D65 | | Salinity Dam-West-SW 87th Ave. |
| D66 | | Old Cutler Road |
| D67 | Bel-Aire Canal | Caribbean Blvd - Bel-Aire |
| D68 | | Fla. Utilities Downstream |
| D69 | Black Creek Canal | Flood Control Dam |
| D70 | | US #1 - South |
| D71 | | US #1 - North |
| D72 | | Broad Channel - Downstream |
| D73 | | Coral Reef Drive |
| D74 | | Richmond Drive |
| D75 | | Eureka Dr. - East |
| D76 | | Quail Roost Drive |
| D77 | | Eureka Dr. - West |
| D78 | | Railroad Bridge |
| D79 | | Dog Leg Turn |
| D80 | | Krome Ave. |
| D81 | Snapper Creek | Red Road-Salinity Dam-South |
| D82 | | Red Road-Salinity Dam-North |
| D83 | | Red Road Bridge at Kendall Dr. |
| D84 | | Dixie Highway |
| D85 | | SW 76th Ave. |
| D86 | | SW 87th Ave. |
| D87 | | SW 97th Ave. |
| D88 | | Sunset Drive |

APPENDIX A-1 (Continued)

SAMPLING STATIONS

| STATION | CANAL | LOCATION |
|---|---|---|
| D89 | Snapper Creek | Miller Road |
| D90 | | SW 40th St. |
| D91 | | SW 24th St. |
| D92 | | Tamiami Trail |
| D93 | Southern Canal | SW 31st St. and 120th Rd. - Upstream |
| D94 | | 11778 SW Village Green Dr. - Downstream |
| D95 | Coral Gables Waterway | LeJeune Rd. |
| D96 | | Dixie Highway North |
| D97 | | Dixie Highway South |
| D98 | | Student Lake - South Footbridge |
| D99 | | Student Lake - Behind Ring Theatre |
| D100 | | Student Lake - North Footbridge |
| D101 | | Bird Road |
| D102 | | Golf Course Footbridge |
| D103 | | Alhambra |
| D104 | | Red Road Dam - East |
| D105 | | Red Road Dam - West |
| D106 | | SW 67th Ave. |
| D107 | | Coral Way |
| D108 | | SW 8th St. |
| D109 | Miami River | Brickell Ave. |
| D110 | | NW 5th St. Bridge |
| D111 | | Wagner Creek |
| D112 | | NW 27th Ave. |
| D113 | Comfort Canal | NW 22nd Ave. |
| D114 | | NW 27th Ave. - East of Dam |
| D115 | | NW 27th Ave. - West of Dam |
| D116 | | NW 37th Ave. |
| D117 | Tamiami Canal | SRD - Miami Paper |
| D118 | | NW 21st St. |
| D119 | | Lejeune Rd. |
| D120 | | NW 57th Ave. and 7th St. |
| D121 | | SW 72nd Ave. and Flagler St. |
| D122 | | SW 87th Ave. |
| D123 | | SW 97th Ave. |
| D124 | | SW 137th Ave. & Tamiami Trail |
| D125 | FEC Canal | NW 25th St. |
| D126 | | NW 58th St. - Air Control |
| D127 | | Atomic Plant |
| D128 | | Rendering Plant |
| D129 | Miami River | Maule Bridge |
| D130 | | Lehigh Bridge |
| D131 | | Railroad Bridge |
| D132 | Borrow Canal | Rosedale and Ludlam |
| D133 | | NW 36th St. |
| D134 | Melrose Canal | Melrose and Osage Dr. |
| D135 | | Morningside and S. Esplanade |

APPENDIX A-1 (Continued)

SAMPLING STATIONS

| STATION | CANAL | LOCATION |
|---|---|---|
| D136 | Miami River | NW 47th Ave. |
| D137 | | S. of 36th St. Bridge - N. of Dam |
| D138 | | S. of Dam - 36th St. |
| D139 | Biscayne Canal | Above Salinity Dam - West |
| D140 | | Below Salinity Dam - East |
| D141 | | 113th St. and NE 6th Ave. |
| D142 | | W. Dixie Highway |
| D143 | | NE 131st St. |
| D144 | | 135th St. and Griffing Blvd |
| D145 | | Memorial Highway and Miami Ave. |
| D146 | | 154th St. and NW 7th Ave. |
| D147 | | NW 22nd Ave. - Opa Locka Blvd. |
| D148 | | Atlantic and Sesame |
| D149 | | NW 60th Ave. and 138th St. |
| D150 | | NW 67th Ave. and 138th St. |
| D151 | | W 18th Ave. and 84th St. |
| D152 | | NW 67th Ave. and 166th St. |
| D153 | | Red Road |
| D154 | | NW 32nd Ave. and 153rd St. |
| D155 | Snake Creek | (East of Salinity Dam) Bridge |
| D156 | | US #1 and Dixie Highway - West of Dam |
| D157 | | 170th St. and NE 15th Ave. |
| D158 | | Miami Gardens Dr. & NE 13th Ave.-183rd St. |
| D159 | | Rt 441 - NW 2nd Ave. |
| D160 | | Sunshine State Parkway |
| D161 | | NW 27th Ave. |
| D162 | | Bridge at NW 27th Ave. - Canal B |
| D163 | | NW 27th Ave. & 207th St. - Miramar Canal |
| D164 | | NW 37th Ave. |
| D165 | | Carol City Canal Bridge-NW 39th Ave. |
| D166 | | NW 47th Ave. |
| D167 | | NW 67th Ave. |
| D168 | | NW 77th Ave. |
| D169 | | NW 175th St. & 77th Ct. - Peter Pike |
| D170 | | NW 179th St. & 77th Ct. - Peter Pike |
| D171 | C-103 | Tallahassee Rd. (SW 137th Ave.) |
| D172 | | Bridge East of Tallahassee Rd. (SW 137th Ave) |
| D173 | | Campbell Dr. (SW 312th St. & 150th Ave) |
| D174 | | US #1 - South |
| D175 | | Tennessee Rd. - 167th Ave. |
| D176 | | Krome Ave. |
| D177 | | Campbell Dr. (SW 312th St. & 137th Ave) |
| D178 | | Biscayne Dr. (SW 288th St.) |
| D179 | | US #1 - North |
| D180 | | Tennessee Road |

APPENDIX A-1 (Continued)

SAMPLING STATIONS

Dade County

Miami Beach Bacteriological Water Quality Data

Dade County Health Department

| STATION | | LOCATION |
|---|---|---|
| D201 | Atlantic Ocean | Miami Beach Pier |
| D202 | | 10th Street |
| D203 | | 15th Street |
| D204 | | 21st Street |
| D205 | | 31st Street |
| D206 | | 36th Street |
| D207 | | 43rd Street |
| D208 | | 65th Street |
| D209 | | 69th Street |
| D210 | | 71st Street |
| D211 | | 74th Street |
| D212 | | 76th Street |
| D213 | | 80th Street |
| D214 | | 84th Street |
| D215 | | 88th Street |
| D216 | | 96th Street |
| D217 | | Bakers Haulover |
| D218 | | Haulover Pier |
| D219 | | 175th Street |
| D220 | | Golden Beach |

APPENDIX A-1 (Continued)

SAMPLING STATIONS

Dade County

Federal Water Quality Administration

| STATION | LOCATION |
|---|---|
| 1 | Coral Gables Waterway, North Branch at eastern tip sea wall and Channel Marker. |
| 2 | South branch Coral Gables Waterway, in mouth of canal as it enters Biscayne Bay at east end sea wall. |
| 3 | Matheson Hammock Park, west of junction of incoming canals, between flag pole and channel marker, entrance to harbor. |
| 4 | Snapper Creek Canal at mouth at entrance to Biscayne Bay. |
| 5 | Florida City Canal at mouth as it enters Biscayne Bay. |
| 6 | Military Canal at mouth as it enters Biscayne Bay. |
| 7 | Dinner Key Marina off east end of Pier 5. |
| 8 | Biscayne Bay south of Fair Isle Causeway, due east of Tennis Courts (Coconut Grove), south of 2 white buildings. Off shore about 50 feet near a sewage outfall. |
| 9 | Rickenbacker Causeway, east end, on north side bridge near shore, close to large rectangular hole in bulkhead. |
| 10 | Bear Cut, south on west of Bear Cut Bridge about mid-channel, between Institute of Marine Sciences seahut and Crandon Marina. |
| 11 | Government Cut between Fisher Island and Miami Beach. Between Channel Markers 13 and 2M. Near Belcher Oil Tank Farm and Coast Guard Base. |
| 12 | Government Cut between Chalks Flying Service on Watson Park Island and west end of Dodge Island. |
| 13 | Biscayne Island (south side) (Venetian Causeway) along row of apartment buildings (cream colored). |
| 14 | Miami River at mouth between Brickell Point and DuPont Plaza Hotel. West of Brickell Avenue Bridge. |
| 15 | Little River Canal, south branch, at mouth as it enters north Biscayne Bay. |
| 16 | Little River canal, north branch, at mouth as it enters north Biscayne Bay. |
| 17 | Biscayne Canal at mouth at entrance to north Biscayne Bay. Near a large (tall) cream-colored apartment building. |
| 18 | Arch Creek at south end Keystone Islands. Inside bridge (W) from road branching off from Broad Causeway. Near a motel. |
| 19 | Near Arch Creek, in dredged channel just before first basin at north end of Keystone Islands complex. |
| 20 | Intracoastal Waterway at Golden Beach at second oval man-made island, across from lance-shaped tributary lagoon extending west. |

APPENDIX A-1 (Continued)

SAMPLING STATIONS

| STATION | LOCATION |
|---|---|
| 21 | Oleta River near SR 826 (North Miami Beach Boulevard) highway bridge, down stream from fishing camp and Maule Lake. |
| 22 | Intrecoastal Waterway south of Sunny Isles complex, at ICWW Channel Marker No. 61. |
| 23 | Intracoastal Waterway north of Sunny Isles complex at ICWW Channel Marker No. 57. |
| 24 | Maule Lake effluent canal, north end lake, west of ICWW Channel Marker No. 55, narrow neck between lake and canal. |
| 25 | Goulds Canal at mouth, near Standard Oil Station. |
| 26 | C-1 Canal, Black Creek Canal near mouth, below salt water dam. (Note: Enter on south side of breakwater). |
| 27 | Coral Gables Waterway from Ponce De Leon Boulevard at Riviera Drive (north branch). |
| 28 | Coral Gables Waterway from Ponce De Leon at Theodore Dickinson Drive (south branch). |
| 29 | Miami River at N. W. 17th Avenue Bridge. |
| 30 | Snapper Creek Canal from Red Road Bridge (S. W. 57th Avenue) at Intersection North Kendall Drive (S. W. 88th Street). |
| 31 | C-100 Canal at Cutler from Old Cutler Road. |
| 32 | C-1, Black Creek Canal from bridge on Old Cutler Road. |
| 33 | Goulds Canal from bridge on South Allapattah Road. |
| 34 | C-102 from bridge at intersection of S. W. 107th Avenue and Moody Drive. |
| 35 | Military Canal from bridge on S. W. 107th Avenue. |
| 36 | C-103 from Bridge on Six Mile Road. |
| 37 | North Canal from bridge on Six Mile Road. |
| 38 | Florida City Canal from bridge on Six Mile Road and intersection Palm Drive (S. W. 344th Street). |
| 39 | Intracoastal Waterway at Lake Villa, north of bridge. |
| 40 | Little River Canal at North Miami Avenue Bridge. |
| 41 | Biscayne Canal off Griffing Boulevard, near Miami Shores Country Club, from foot bridge from atop USGS gage. |
| 42 | Arch Creek from bridge at US 1. |
| 43 | Snake Creek (Royal Glades Canal) at 19th Avenue. |
| 44 | Oleta River from bridge on Miami Gardens Drive, north end of Greynolds Park. |
| 45 | Dinner Key Boat Basin at Underwood Marina, off from stone house. |
| 46 | C-100 at mouth. |
| 47 | C-102 at mouth. |
| 48 | C-103 at mouth. |
| 49 | North Canal at mouth - Homestead Bayfront Park. (Canal now blocked off - goes to Moung Canal). |

APPENDIX A-1 (Continued)

SAMPLING STATIONS

| STATION | LOCATION |
|---|---|
| 50 | Florida Power and Light Company Turkey Point Power Plant intake canal. |
| 51 | Mouth of Grand Canal, (effluent canal from Turkey Point Power Plant). |
| 52 | Model Land Canal at mouth. |

APPENDIX A-2

SUMMARY OF ANALYTICAL RESULTS

Reconnaisance Samples, Miami to Hollywood, Florida

Rivers, Canals and Intracoastal Waterway

| Station Number | Water Temp °C | pH | DO mg/l | BOD mg/l | Cl mg/l | Total $PO_4$ as P mg/l | Soluble $PO_4$ as P | TKN-N as N | $NH_3$-N as N | $NO_3$-N as N | No. of Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 7.9 | 6.7 | 1.7 | 15,800 | 0.08 | 0.06 | 0.22 | 0.10 | 0.16 | 6 |
| 2 | 24.5 | 8.0 | 7.0 | 1.4 | 17,000 | 0.02 | 0.05 | 0.17 | 0.05 | 0.01 | 5 |
| 3 | 22.5 | 7.9 | 7.0 | 1.6 | 17,200 | 0.04 | 0.01 | 0.22 | 0.02 | 0.01 | 3 |
| 4 | 21.0 | 7.7 | 5.0 | 1.2 | 15,200 | 0.08 | 0.07 | 0.44 | 0.45 | 0.11 | 8 |
| 5 | 21.5 | 7.7 | 6.7 | 2.3 | 13,700 | 0.06 | 0.03 | 0.43 | 0.24 | 0.01 | 7 |
| 6 | 23.5 | 7.8 | 3.9 | 4.2 | 9,100 | 0.40 | 0.39 | 0.68 | 0.41 | 0.09 | 8 |
| 7 | 23.5 | 8.0 | 6.8 | 2.0 | 17,500 | 0.03 | 0.01 | 0.18 | 0.04 | 0.01 | 6 |
| 8 | 23.5 | 8.1 | 7.4 | 2.6 | 17,800 | 0.12 | 0.02 | 0.29 | 0.11 | 0.01 | 5 |
| 9 | 20.5 | 8.0 | 7.4 | 2.0 | 18,600 | 0.04 | 0.02 | 0.15 | 0.02 | 0.01 | 1 |
| 10 | 24.0 | 8.1 | 7.4 | 1.7 | 19,400 | 0.04 | 0.03 | 0.06 | 0.03 | 0.02 | 4 |
| 11 | 24.0 | 8.1 | 7.1 | 1.3 | 19,300 | 0.02 | 0.03 | 0.04 | 0.03 | 0.01 | 3 |
| 12 | 21.5 | 8.1 | 7.6 | 2.0 | 18,100 | 0.02 | 0.02 | 0.14 | 0.03 | 0.01 | 3 |
| 13 | 22.0 | 8.0 | 8.4 | 1.9 | 18,200 | 0.02 | 0.01 | 0.10 | 0.02 | 0.01 | 2 |
| 14 | 23.0 | 7.9 | 5.6 | 1.2 | 14,300 | 0.03 | 0.02 | 0.34 | 0.13 | 0.05 | 10 |
| 15 | 24.0 | 7.9 | 5.4 | 1.6 | 11,500 | 0.07 | 0.05 | 0.44 | 0.19 | 0.10 | 7 |
| 16 | 22.5 | 7.9 | 6.1 | 1.6 | 14,400 | 0.05 | 0.04 | 0.28 | 0.06 | 0.06 | 7 |
| 17 | 24.5 | 8.0 | 6.0 | 1.2 | 15,000 | 0.04 | 0.03 | 0.21 | 0.10 | 0.02 | 6 |
| 18 | 24.5 | 8.1 | 7.0 | 2.6 | 17,900 | 0.06 | 0.04 | 0.13 | 0.03 | 0.01 | 5 |
| 19 | 25.0 | 8.1 | 7.3 | 1.4 | 18,800 | 0.04 | 0.02 | 0.05 | 0.04 | 0.01 | 5 |
| 20 | 25.5 | 7.7 | 5.9 | 1.4 | 14,500 | 0.24 | 0.11 | 0.47 | 0.27 | 0.22 | 7 |
| 21 | 23.5 | 7.6 | 5.7 | 2.1 | 8,300 | 0.21 | 0.17 | 0.59 | 0.18 | 0.22 | 10 |
| 22 | 27.5 | 8.0 | 7.1 | 2.2 | 12,200 | 0.07 | 0.06 | 0.20 | 0.07 | 0.05 | 7 |
| 23 | 24.5 | 7.9 | 6.9 | 1.8 | 13,100 | 0.07 | 0.06 | 0.23 | 0.12 | 0.19 | 10 |
| 24 | 24.5 | 7.8 | 7.1 | 2.7 | 10,900 | 0.18 | 0.14 | 0.60 | 0.25 | 0.20 | 6 |
| 25 | 22.5 | 8.0 | 4.9 | 1.6 | 11,100 | 0.21 | 0.22 | 0.47 | 0.24 | 0.10 | 5 |
| 26 | 23.5 | 8.0 | 4.2 | 2.0 | 9,100 | 0.34 | 0.32 | 0.66 | 0.38 | 0.15 | 5 |
| 27 | 24.0 | 7.4 | 3.9 | 1.9 | 4,800 | 0.34 | 0.33 | 0.61 | 0.39 | 0.70 | 11 |
| 28 | 24.0 | 7.4 | 6.0 | 1.3 | 3,800 | 0.13 | 0.16 | 0.21 | 0.06 | 0.81 | 11 |
| 29 | 23.5 | 7.6 | 2.8 | 1.0 | 2,000 | 0.05 | 0.05 | 0.79 | 0.32 | 0.15 | 10 |
| 30 | 23.5 | 7.5 | 2.7 | 3.9 | 47 | 0.73 | 0.66 | 2.0 | 1.32 | 0.18 | 10 |

APPENDIX A-2 (Continued)

| Station Number | Water Temp °C | pH | DO mg/l | BOD mg/l | Cl mg/l | Total $PO_4$ as P mg/l | Soluble $PO_4$ as P | TKN-N as N | $NH_3$-N as N | $NO_3$-N as N | No. of Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 31 | 23.5 | 7.7 | 8.2 | 1.0 | 34 | 0.01 | 0.01 | 0.12 | 0.02 | 0.01 | 10 |
| 32 | 24.0 | 7.4 | 5.6 | 4.9 | 33 | 1.12 | 0.89 | 2.19 | 1.40 | 0.26 | 10 |
| 33 | 24.0 | 7.6 | 6.6 | 1.0 | 56 | 0.02 | 0.04 | 0.04 | 0.05 | 3.28 | 7 |
| 34 | 24.0 | 7.4 | 8.5 | 0.56 | 36 | 0.01 | 0.02 | 0.02 | 0.02 | 1.56 | 9 |
| 35 | 24.5 | 7.8 | 6.9 | 15.1 | 94 | 2.50 | 2.12 | 4.18 | 2.91 | 0.84 | 12 |
| 36 | 23.5 | 7.7 | 7.6 | 1.7 | 108 | 0.02 | 0.01 | 0.15 | 0.02 | 1.14 | 6 |
| 37 | 24.0 | 7.7 | 8.8 | 1.6 | 51 | 0.02 | 0.02 | 0.18 | 0.04 | 0.95 | 7 |
| 38 | 24.0 | 7.6 | 6.8 | 1.2 | 48 | 0.01 | 0.02 | 0.14 | 0.03 | 0.95 | 6 |
| 39 | 25.0 | 7.7 | 6.1 | 1.8 | 14,300 | 0.23 | 0.20 | 0.05 | 0.32 | 0.21 | 6 |
| 40 | 24.0 | 7.7 | 3.1 | 1.8 | 590 | 0.13 | 0.10 | 0.77 | 0.13 | 0.31 | 9 |
| 41 | 24.0 | 8.0 | 8.3 | 3.1 | 57 | 0.11 | 0.28 | 0.64 | 0.09 | 0.03 | 9 |
| 42 | 24.5 | 7.8 | 6.0 | 1.7 | 14,100 | 0.06 | 0.04 | 0.23 | 0.11 | 0.06 | 9 |
| 43 | 24.0 | 7.9 | 6.6 | 3.4 | 128 | 0.31 | 0.29 | 0.98 | 0.31 | 0.46 | 9 |
| 44 | 24.0 | 7.6 | 4.7 | 1.7 | 5,900 | 0.64 | 0.64 | 0.95 | 0.60 | 0.46 | 8 |
| 45 | 24.5 | 8.1 | 6.8 | 1.8 | 17,600 | 0.24 | 0.016 | 0.24 | 0.03 | 0.01 | 3 |
| 46 | 25.0 | 8.4 | 6.6 | 1.7 | 13,100 | 0.015 | 0.010 | 0.20 | 0.03 | 0.02 | 3 |
| 47 | 23.5 | 7.9 | 5.9 | 2.2 | 6,900 | 0.02 | 0.02 | 0.31 | 0.08 | 0.50 | 4 |
| 48 | 23.5 | 7.7 | 5.4 | 3.0 | 10,200 | 0.02 | 0.02 | 0.27 | 0.08 | 0.05 | 5 |
| 49 | 21.5 | 7.7 | 4.0 | 2.6 | 15,800 | 0.08 | 0.07 | 0.32 | 0.20 | 0.02 | 1 |
| 50 | 24.0 | 8.1 | 7.6 | 0.8 | 15,200 | 0.01 | 0.02 | 0.19 | 0.07 | 0.05 | 4 |
| 51 | 28.5 | 8.1 | 7.7 | 1.9 | 16,100 | 0.02 | 0.05 | 0.14 | 0.04 | 0.04 | 4 |
| 52 | 23.0 | 7.6 | 4.9 | 1.0 | 14,800 | 0.01 | 0.01 | 0.33 | 0.18 | 0.05 | 2 |

NOTE: Analytical results given for sampling stations 1-52 are average values for the number of samples indicated. Samples were collected at mid-depth intermittently during the period February-May 1969.